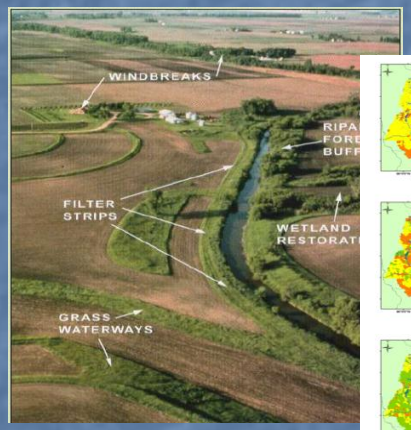
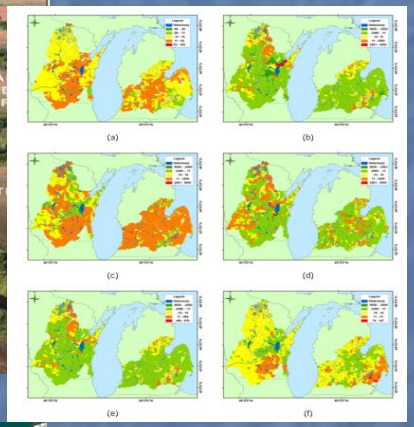
An Overview of the TNC Watershed Strategy & Great Lakes CEAP Project

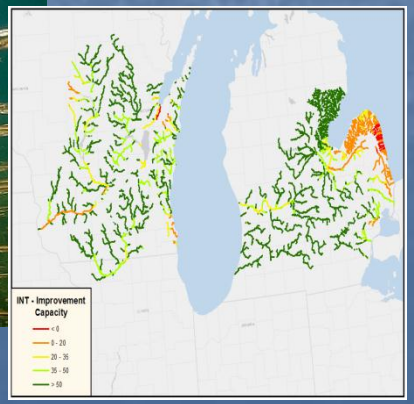
Scott P. Sowa, Matthew Herbert, Layla Cole, Sagar Mysorekar, Tia Bowe, Lizhu Wang, A. Pouyan Nejadhashemi, Jon Bartholic, & Charles Rewa

WLEB CEAP WebEx

May 16, 2012







Elements of Presentation

- Overview of TNC's Watershed Strategy
- Overview of Great Lakes CEAP Project and related elements of TNC Watershed Strategy
  - Foundations of our approach
  - Goal, general approach and core questions
  - Focal elements and important caveats
  - Approach
  - Results and Current Status
  - Future Directions

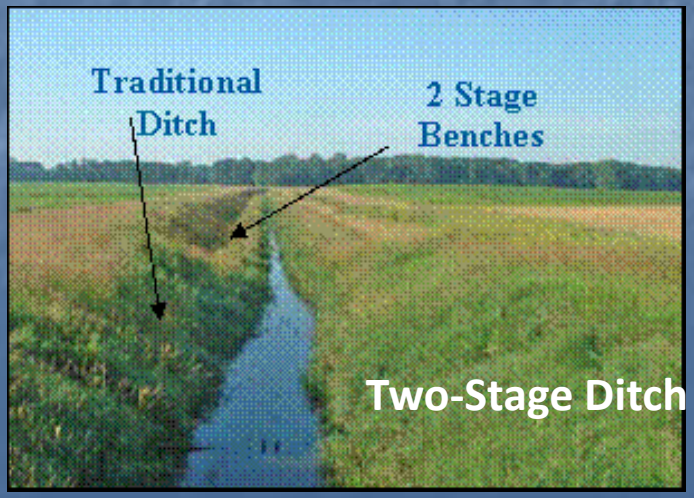
The Nature Conservancy
Protecting nature. Preserving life.™

Agriculture has a major effect on the Conservancy's mission.

TNC's Traditional Approach in Agricultural Watersheds

How much?

Where will they have the most impact?



Can we get there by educating farmers and with Farm Bill incentives?

The Nature Conservancy
Protecting nature. Preserving life.™

Questions to Answer to Improve Hydrologic Function, Water Quality, & Biota

- How much, and Where?
  - Determine relationships between BMP and environmental improvement (Dose-response curve)
  - Define success and set environmental goals
- How to motivate at scale?
  - Create new reward for performance transactions to achieve the goals

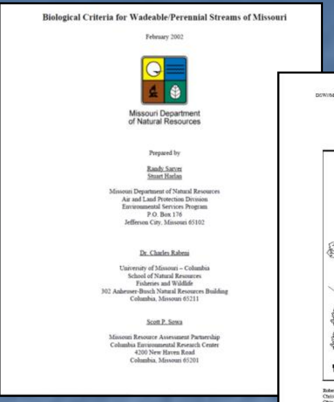
The Nature Conservancy
Protecting nature. Preserving life.™

Great Lakes Agriculture and Altered Hydrology Strategy

- Forecast the amount of BMPs needed.
- Develop, promote hydrological improvement practices.
- Develop, test new incentives and transactions.
- Prove ability to achieve scale at large watersheds.
- Leverage across Basin.

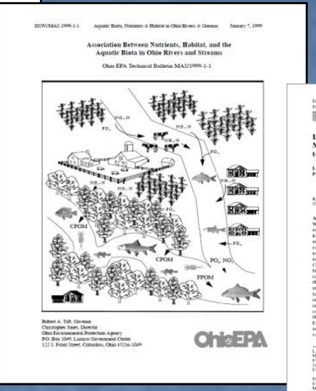
A New Twist on a Seasoned Approach

- Clean Water Act
  - Biological criteria
  - Water Quality Criteria
    - TMDL


Biological Criteria for Wadeable/Perennial Streams of Missouri

February 2002

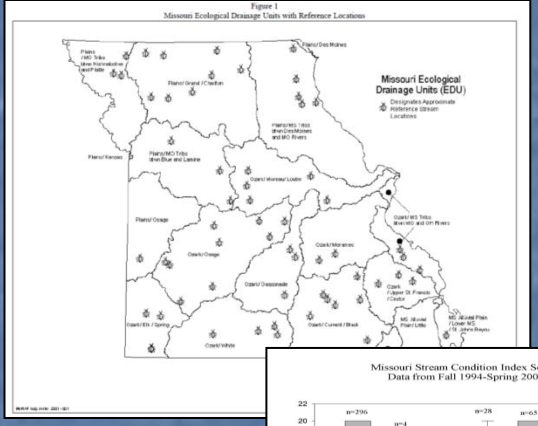
Missouri Department of Natural Resources

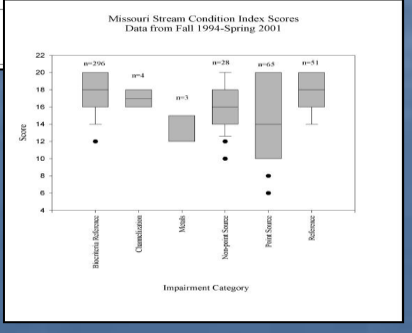

Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams

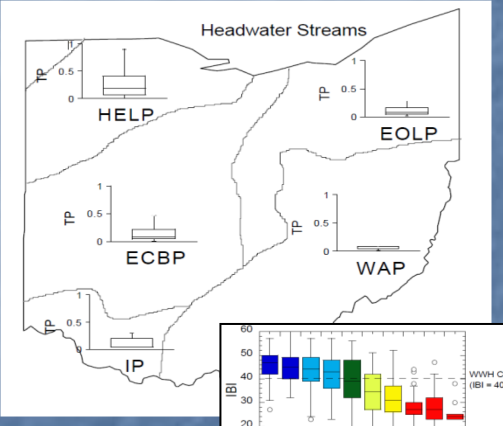
Ohio EPA Technical Bulletin MAS/1999-1-1

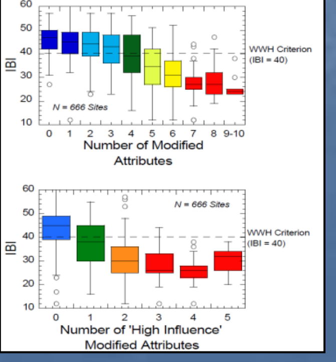

RESEARCH

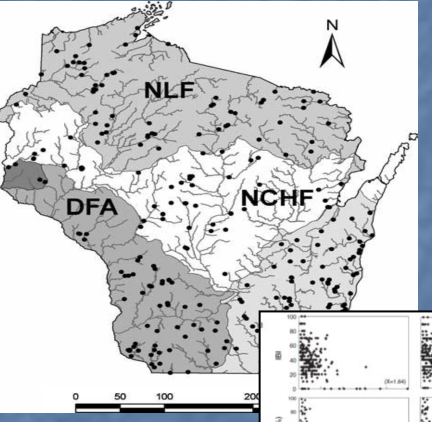
Linkages Between Nutrients and Assemblages of Macroinvertebrates and Fish in Wadeable Streams: Implication to Nutrient Criteria Development

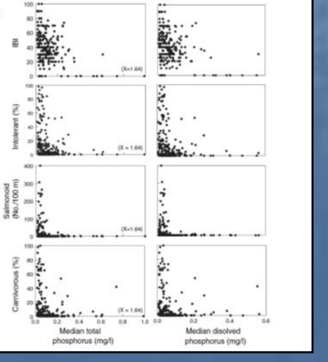








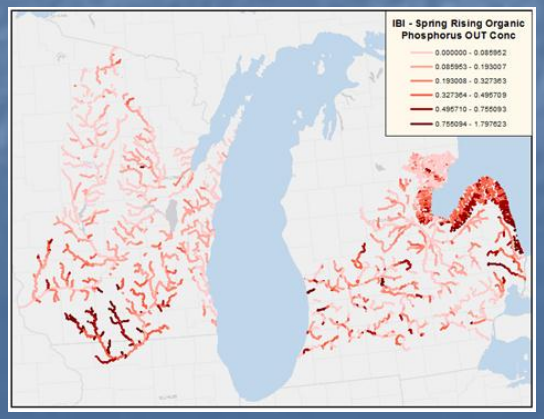


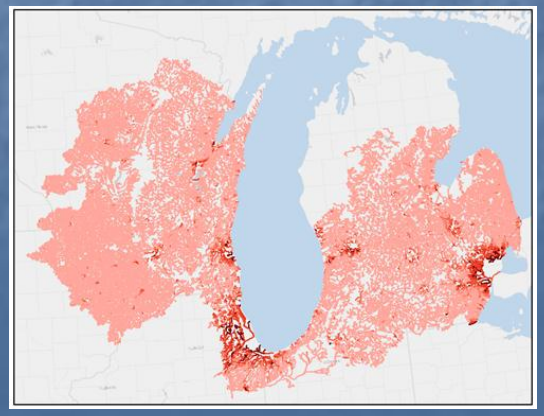


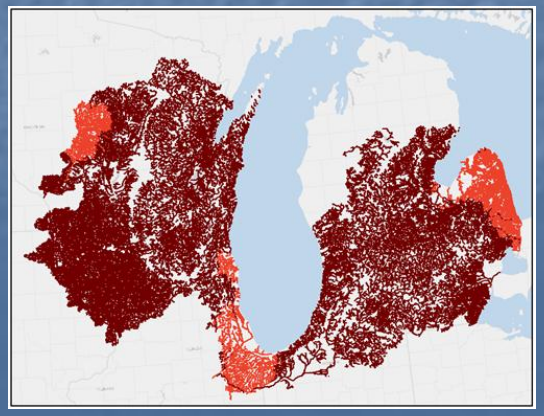
Field-Based vs. GIS-Based Models and Goals

- Field Based
  - Requires user to collect data on predictor variables at site of interest

- GIS-Based
  - Requires modeler to have spatially comprehensive data on all predictor variables across region of interest

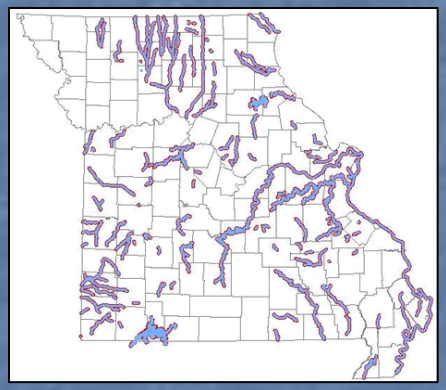


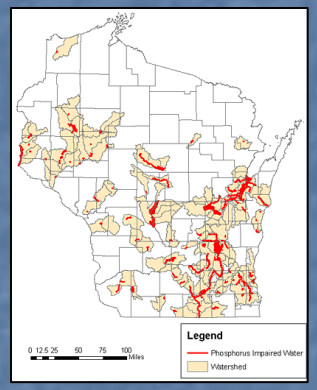




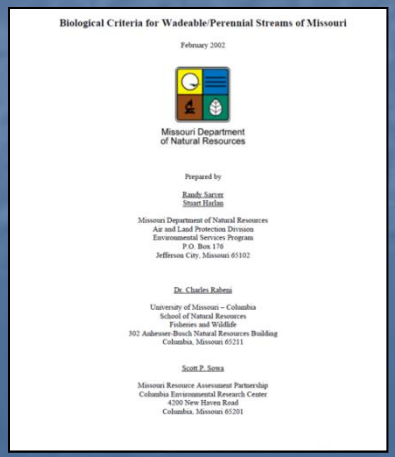
Old Way Has Some Limitations

- Can't assess all waters from field samples
  - In Missouri we assessed 0.03% of stream reaches





- Doesn't always assess if criteria (goals) are realistic
  - How Much will it Cost?


Biological Criteria for Wadeable/Perennial Streams of Missouri

February 2002

Missouri Department of Natural Resources

Prepared by

Randy Sarver
Stuart Harlan

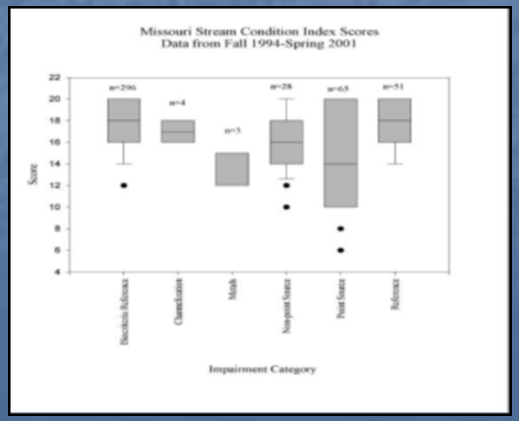
Missouri Department of Natural Resources
Air and Land Protection Division
Environmental Services Program
P.O. Box 176
Jefferson City, Missouri 65102

Dr. Charles Rabeni

University of Missouri – Columbia
School of Natural Resources
Fisheries and Wildlife
302 Anheuser-Busch Natural Resources Building
Columbia, Missouri 65211

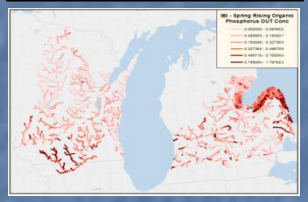
Scott P. Sowa

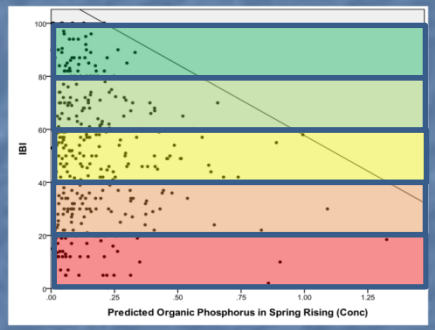
Missouri Resource Assessment Partnership
Columbia Environmental Research Center
4200 New Haven Road
Columbia, Missouri 65201

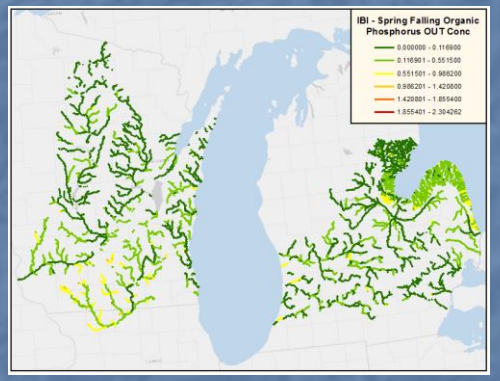


A Complimentary Approach

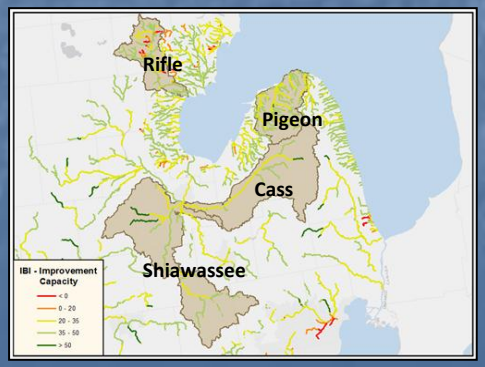
- GIS-Based for spatially-comprehensive coverage

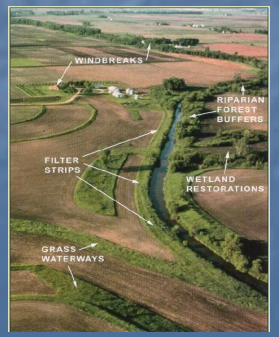


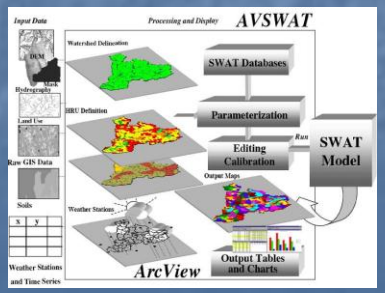


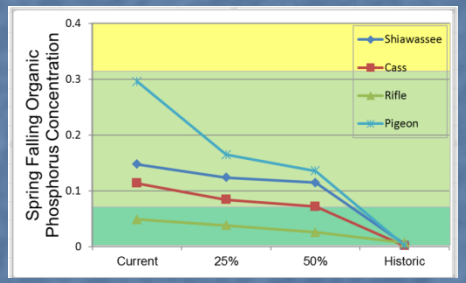


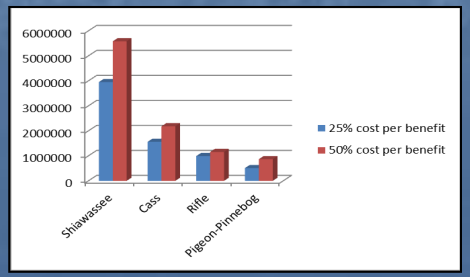
- SWAT-Based to forecast alternative future scenarios and associated costs





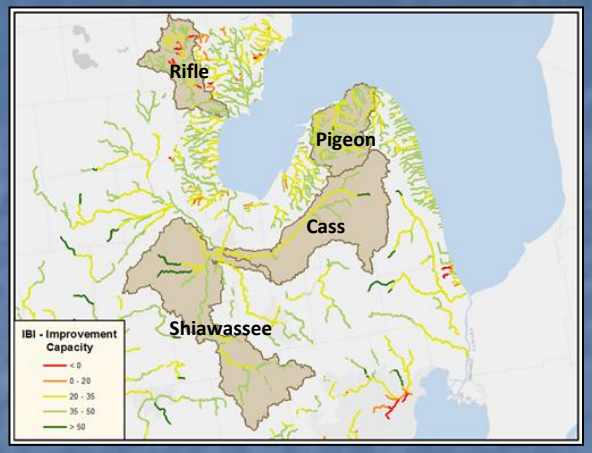




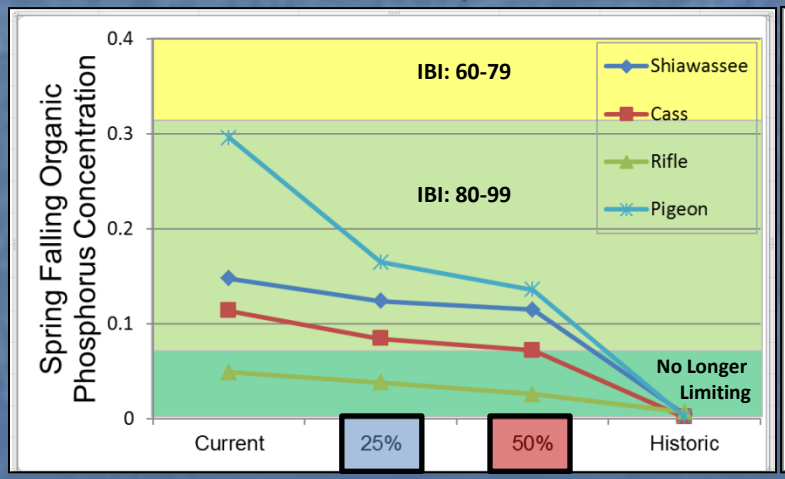


Core Questions

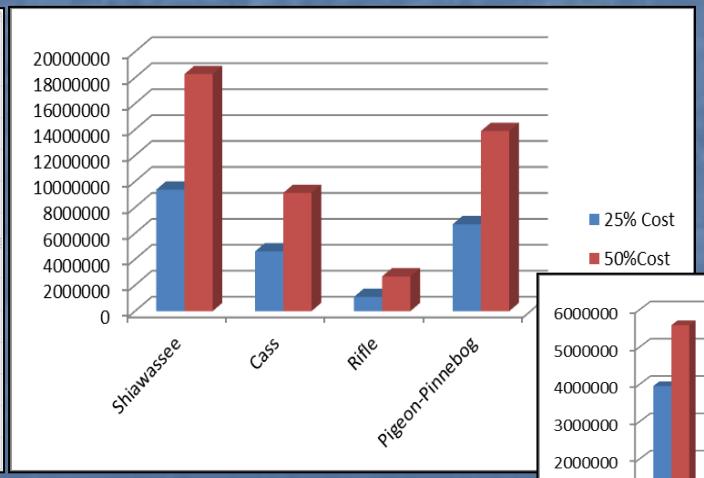
- How much of an investment will it take to achieve different levels of biological integrity?
- What is the cost per unit benefit?



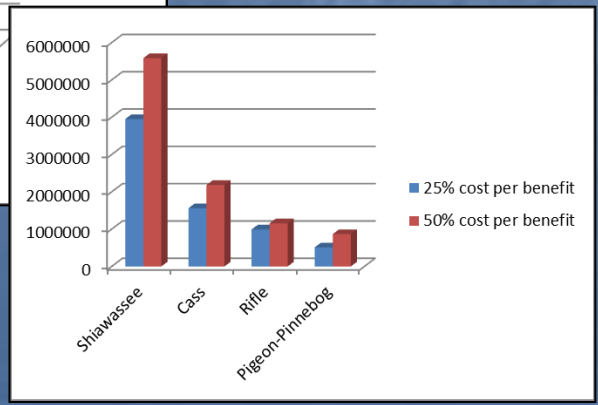
Dose-Response



Total Cost for Scenario

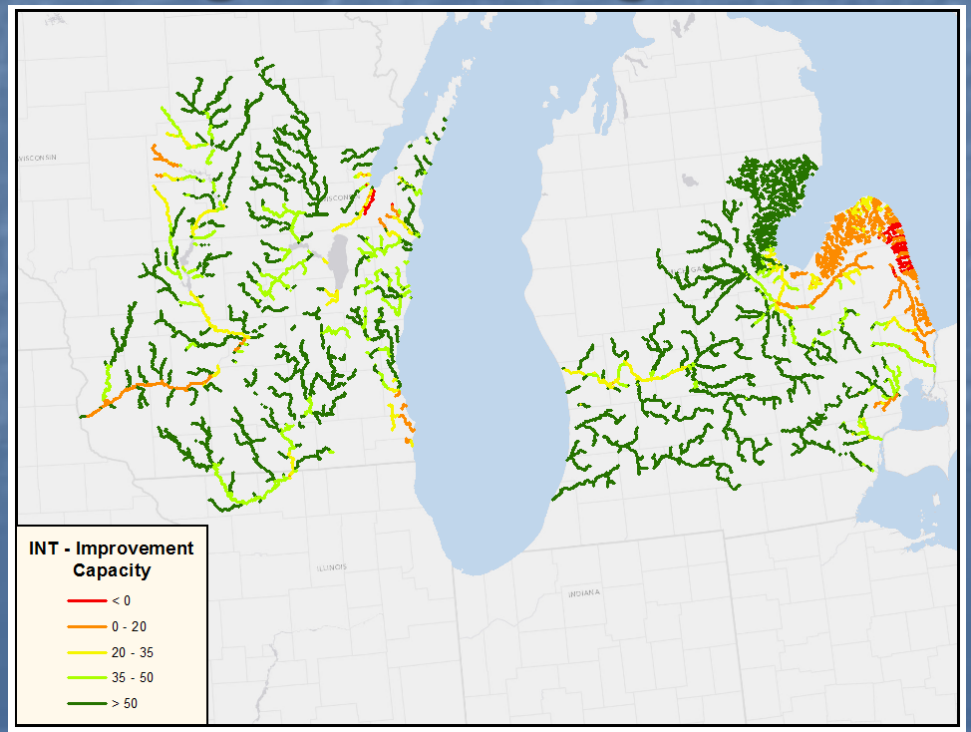


Cost per Unit Benefit



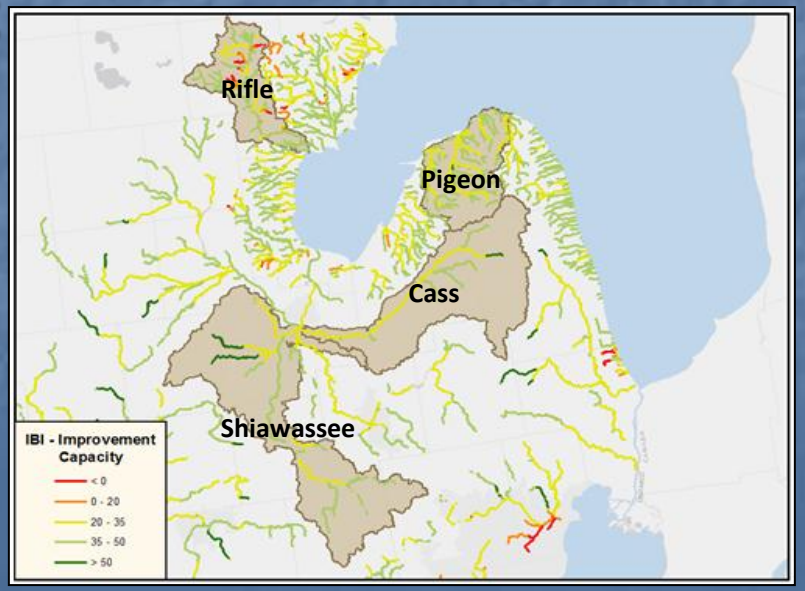
Great Lakes CEAP Project

- GOAL: provide decision makers with information and models on the relations between biological endpoints, water quality/flow, and conservation practices to help establish realistic desired conditions and guide strategic conservation



Realistic Expectations

- Goals that incorporate relevant ecological, logistical, legal, social, and economic realities that; a) determine what is valued by society, b) constrain what is achievable, or c) determine what is acceptable to society
- What are realistic goals for;
  - Rifle?
  - Shiawassee?
  - Cass?
  - Pigeon?



Specific Questions We Are Trying to Address

- Phase 1:
  - What is the relationship between measures of biological integrity and water quality and flow variables?
  - At what point do variables become limiting?
    - Target variables (Ag related water quality and flow)
    - Non target variables (Natural, Urban, etc.)
  - Which streams are limited by Ag related WQ and flow?

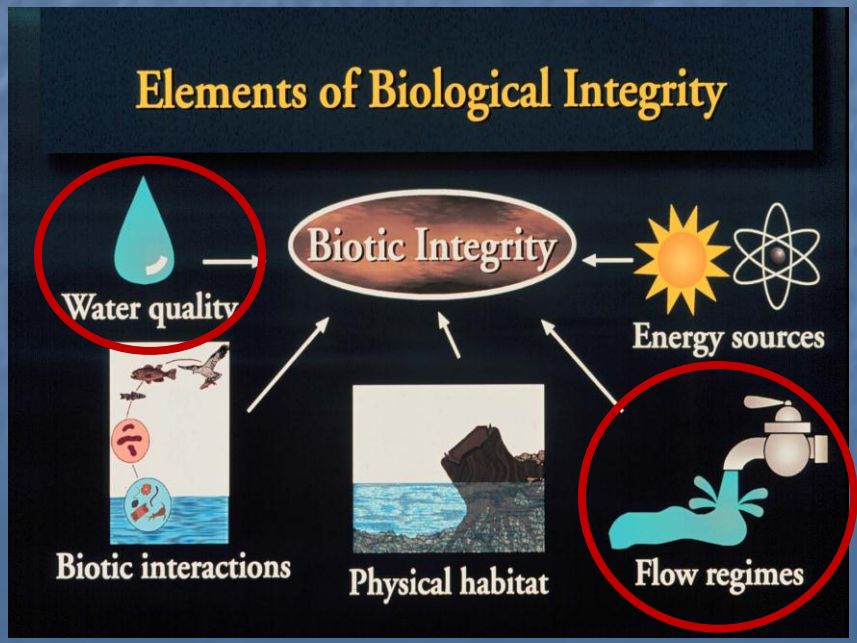
- Phase 2:
  - How much of an investment will it take to remove water quality and flow as limiting factors?
  - What are realistic, biologically-based, water quality and flow goals given:
    - direct and indirect costs of restoration?
    - return on investment?
    - limited public funding or other “funding mechanisms”?
    - logistical constraints of existing AG BMP supply chains?

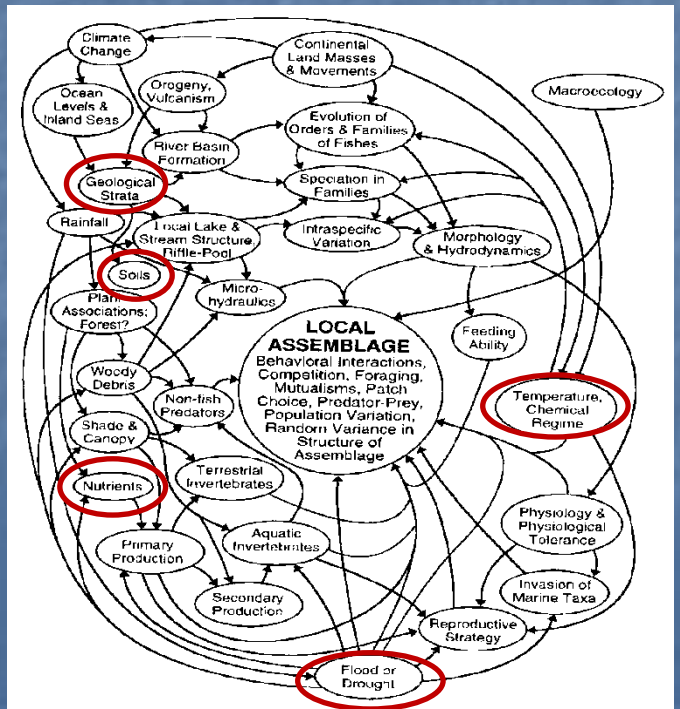
Important Caveats and Cautions

- Out of necessity we are focusing on specific:
  - Source of Disturbance; AG non-point source
    - We do account for other sources(e.g., urban, cattle, dams)
  - Ecosystem: Rivers
  - Biological endpoints: Fish
  - Elements of habitat quality: Sediments, Nutrients, and Flow
  - Conservation practices: 12 AG BMPs
- Our realistic desired conditions and strategies might be insufficient for addressing other issues;
  - E.g., Nearshore ecosystem health/algal blooms

Important Caveats Cont.

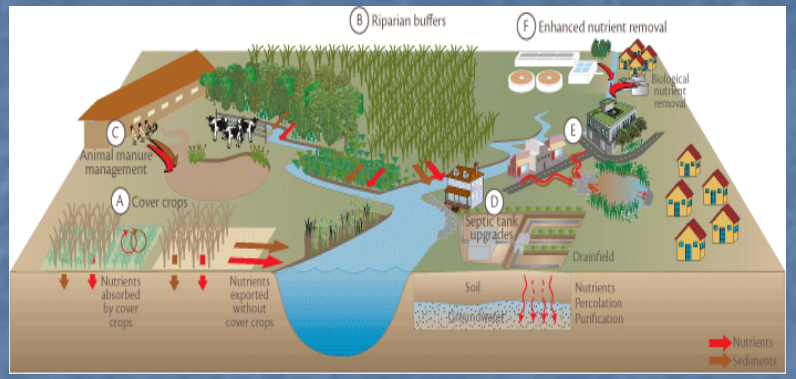
- Water quality and flow are not the only factors that influence biological integrity of streams
- We are addressing only a subset of factors:
  - Be Honest and Transparent
- We are trying to determine at what point are water quality and flow no longer limiting the riverine fish community

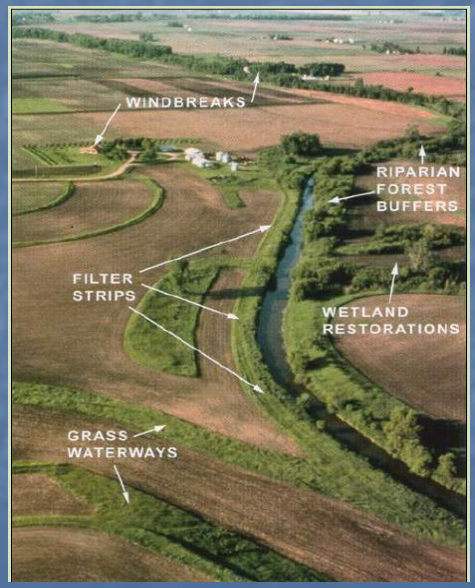




Selected BMPs

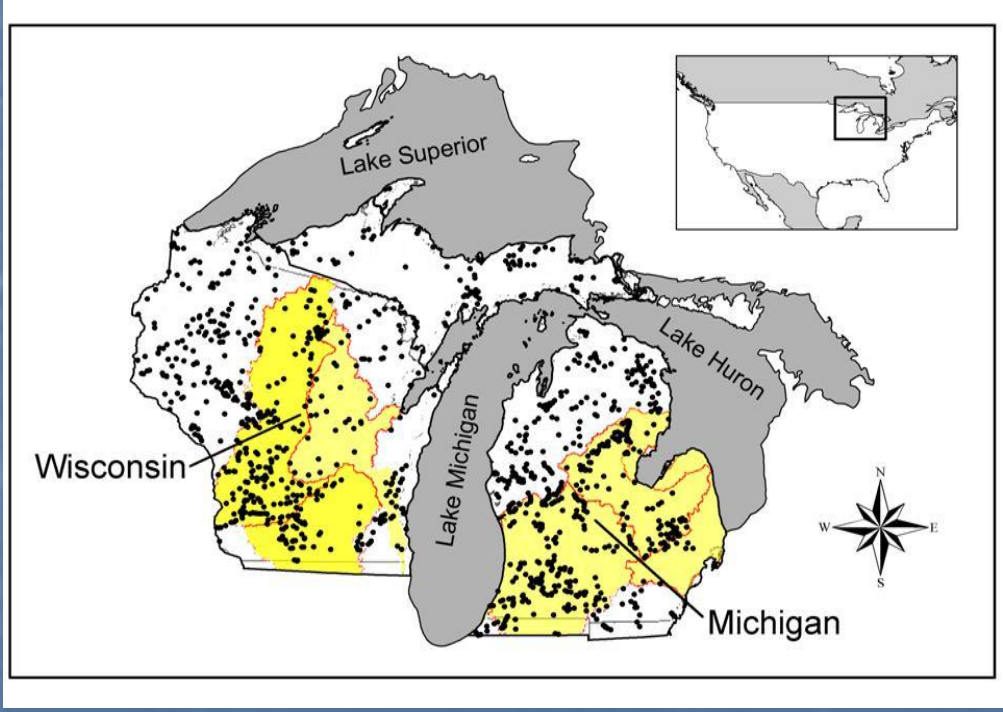
- Nutrient Management/ Waste Utilization
- Conservation Crop Rotation
- Filter Strip
- Conservation Cover
- Residue and Tillage Management
- No-Till/Strip Till/Direct Seed
- Mulch Till, Residue Management
- Residue Management, No-Till/Strip Till
- Cover Crop
- Pasture and Hay Planting
- Wetland Creation/Restoration
- Wetland - Floodplain restoration



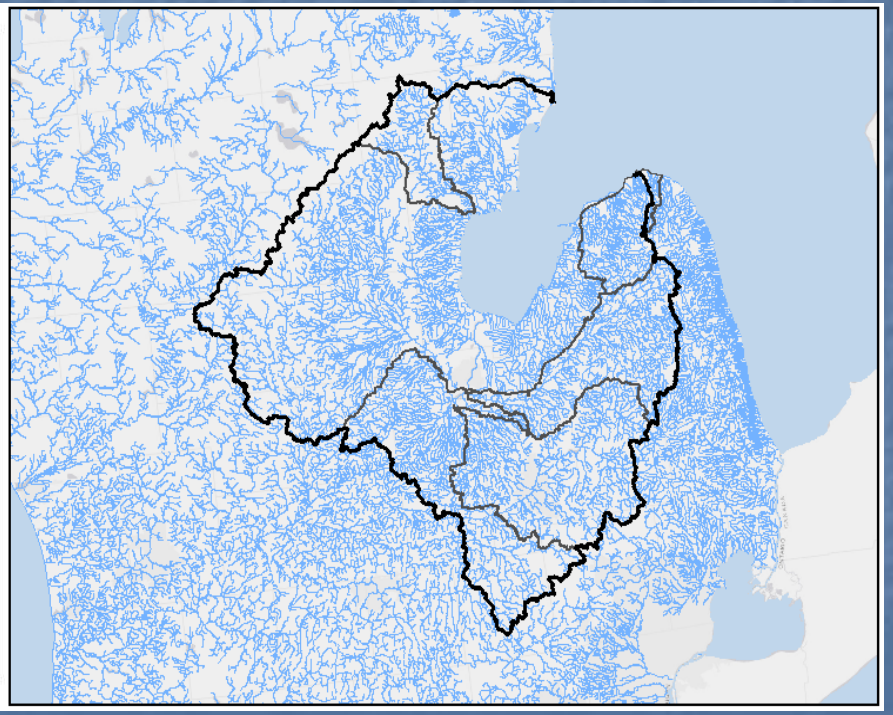


Project Areas

Phase 1



Phase 2

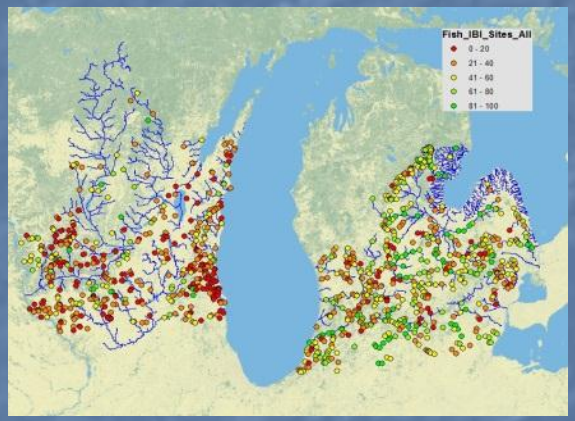


Great Lakes CEAP Phase 1: Major Tasks

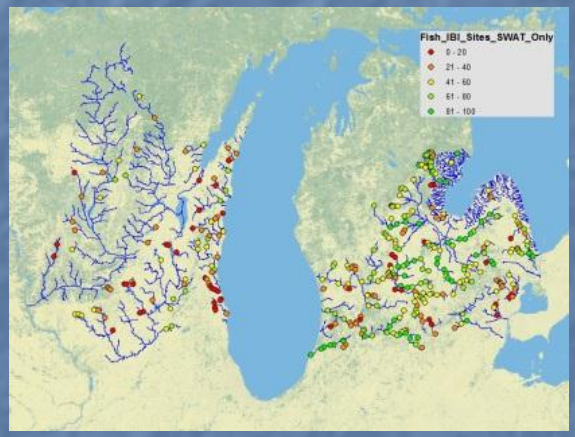
- Model Water Quality and Flow across study area via SWAT
  - Historic (for context) and current land use/cover conditions
- Identify relations and thresholds/ceilings between:
  - Response variables:
    - Fish community Index of Biotic Integrity
    - % of Community Comprised of Intolerant
  - Predictor Variables:
    - Natural Watershed Variables (e.g., groundwater contribution)
    - Non-target disturbances (e.g., %urban)
    - Target predictor variables
      - Water quality and flow variables from SWAT

Response Variables and Sources

- Response variables (N = 1022 or N = 345)
  - Fish Index of Biotic Integrity (IBI)
    - » N = 1022



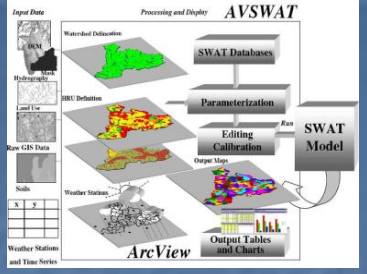
N = 345



  - Relative Abundance of Functional Guilds
    - » Ominvore, Insectivore, Piscivore, Lithophilus, Intolerant

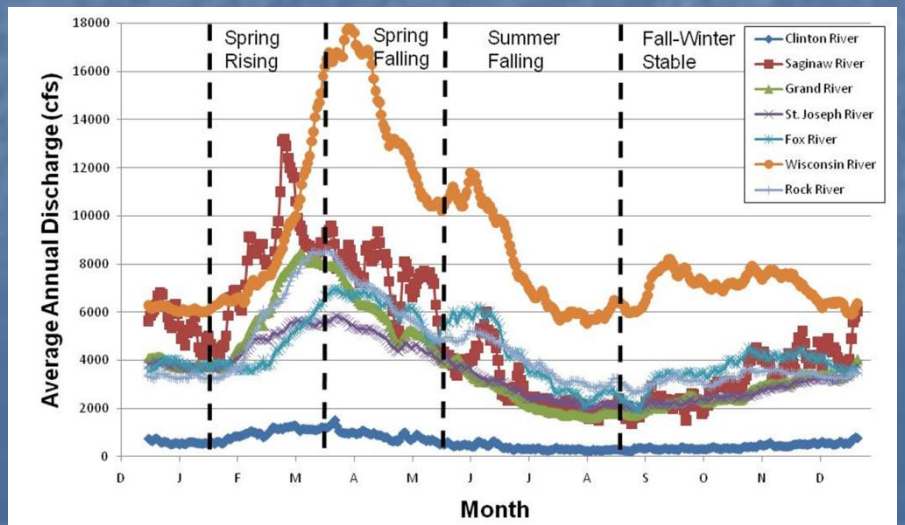
	A	B	C	D	E	F	G	H
1	PUGAP_CODE	IBI	PCINTONB	PCOMNINB	PCINSENB	PCLITHNB	PCPISVNB	PISINSRATIO
2	black596	35.00	3.29	30.21	43.75	34.89	0.00	0.00
3	clint100	57.00	11.59	33.33	43.32	53.30	0.97	0.02
4	clint103	34.50	1.22	22.43	76.76	29.83	0.00	0.00
5	clint108	53.00	22.27	19.09	51.59	50.00	0.23	0.00
6	clint116	35.00	1.40	0.00	20.98	12.59	0.00	0.00
7	clint206	32.00	1.38	13.17	3.82	69.69	0.33	0.09
8	clint224	12.00	0.00	29.58	2.82	45.07	0.70	0.25
9	clint237	49.00	2.39	18.97	49.91	20.63	0.00	0.00
10	clint244	19.00	0.00	26.46	4.79	44.55	1.20	0.25
11	clint249	47.00	26.69	1.40	42.98	35.39	0.28	0.01
12	clint254	87.00	17.42	0.00	84.85	7.58	13.64	0.16
13	clint29	57.00	64.86	8.78	8.78	18.92	0.00	0.00
14	clint299	58.33	18.19	10.08	18.93	33.82	0.00	0.00
15	clint306	47.00	3.28	24.59	11.48	28.96	0.55	0.05
16	clint308	42.33	20.08	15.53	22.63	52.46	0.06	0.00
17	clint355	35.00	0.00	2.25	1.13	23.10	0.85	0.75
18	clint362	59.00	31.92	14.81	35.48	29.07	0.75	0.02
19	clint365	49.00	2.51	58.19	13.38	60.37	2.17	0.16
20	clint393	34.00	8.17	26.14	13.40	56.21	0.33	0.02
21	clint441	37.00	1.90	18.25	6.46	25.10	0.38	0.06

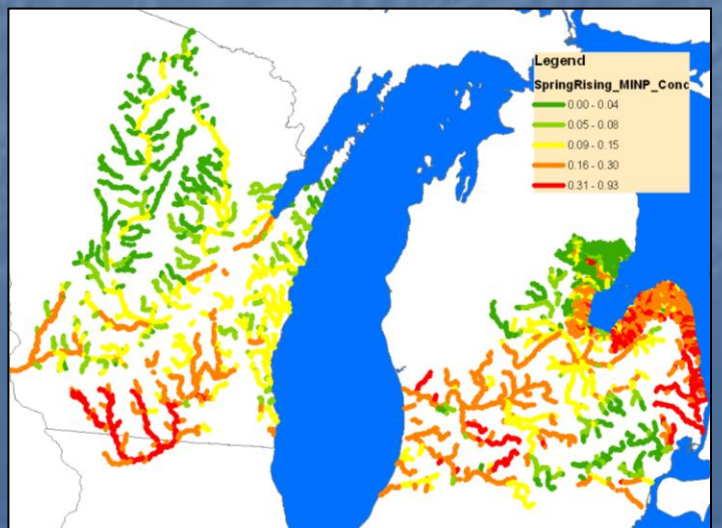
Target Predictor Variables



MICHIGAN STATE UNIVERSITY

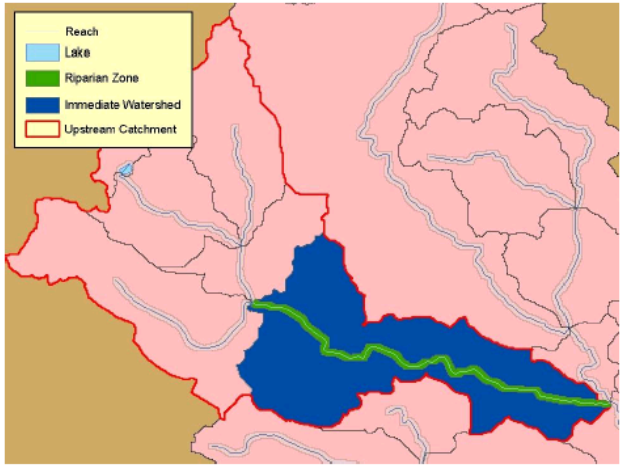
- Modeled (SWAT) Variables (N = 345)
  - Sediments, Nutrients, and Flow
    - » Current, Historic, % change, gross difference
    - » Annual and Seasonal Min, Max, and Means
    - » Runoff, Concentrations and Loads





Other Predictor Variables

- Predictor Variables (N = 1022)
  - Stream size, Drainage Area, Gradient
  - Physiography and Land Cover
  - Non-Target Threats (e.g., %urban)
- Spatial Units
  - Watershed, overall riparian, local catchment, local riparian
- Sources
  - NFHAP Assessment
  - Great Lakes Aquatic GAP



1:100K NHD

NATIONAL FISH HABITAT ACTION PLAN

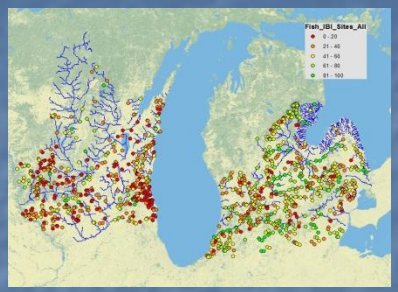
MICHIGAN STATE UNIVERSITY

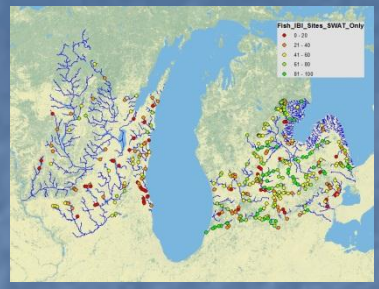
gap KEEPING COMMON SPECIES COMMON

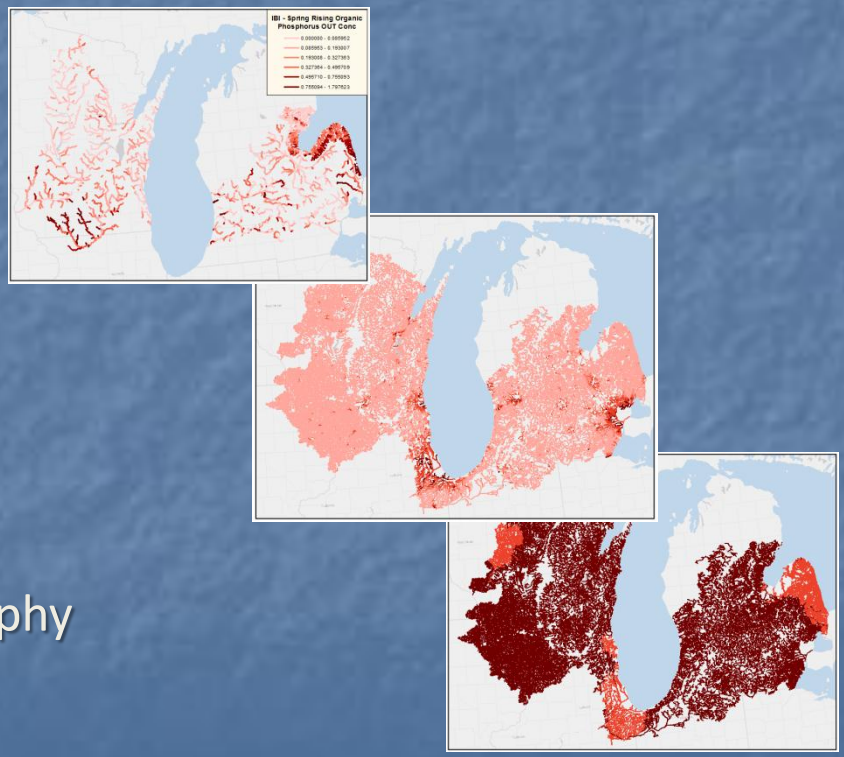
USGS science for a changing world

Identify Thresholds and Relations

- Response Variables
  - IBI and Percent Intolerant Fish
- Predictor Variables
  - Target: (N of 345)
    - SWAT Water Quality and Flow
  - Non-Target: (N of 1022)
    - Watershed Disturbances
  - Natural: (N of 1022)
    - Watershed hydrology/physiography







NATIONAL FISH HABITAT ACTION PLAN

gap KEEPING COMMON SPECIES COMMON

USGS science for a changing world

MICHIGAN STATE UNIVERSITY

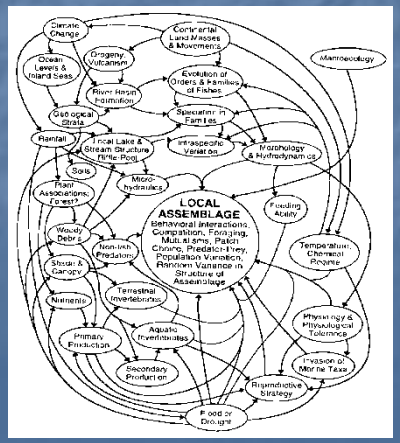
Michigan DNRE Department of NATURAL RESOURCES and ENVIRONMENT

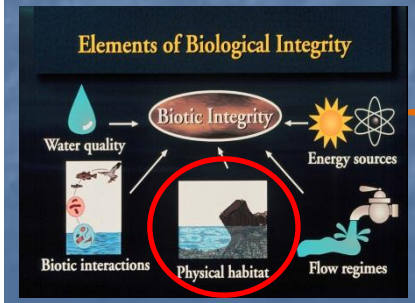
WISCONSIN DEPT. OF NATURAL RESOURCES

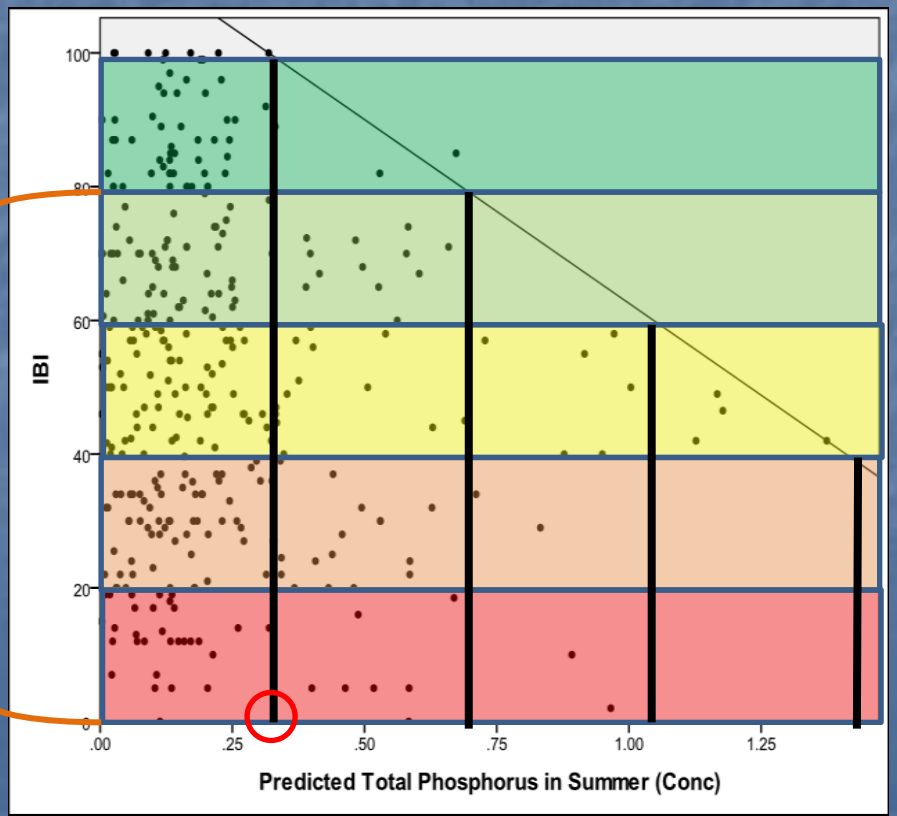
Identify Thresholds and Relations

Deciphering Wedge Plots/Envelopes

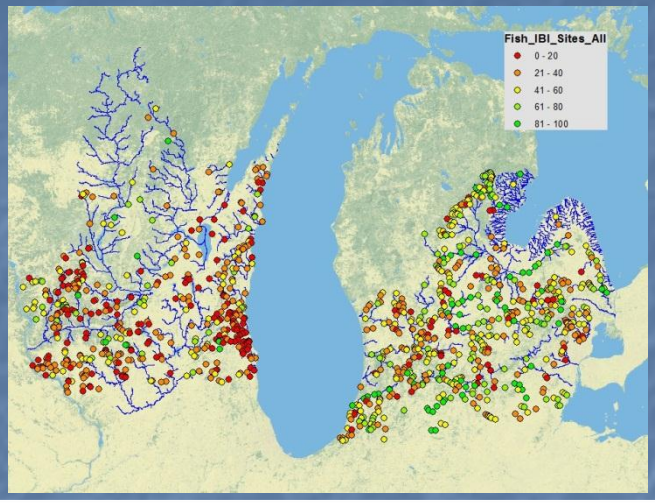
- At what point are water quality and flow variables no longer limiting?
- Other factors often limiting
  - Local physical habitat
    - Sediment, woody debris
  - Contaminants
  - Barriers, Invasive species

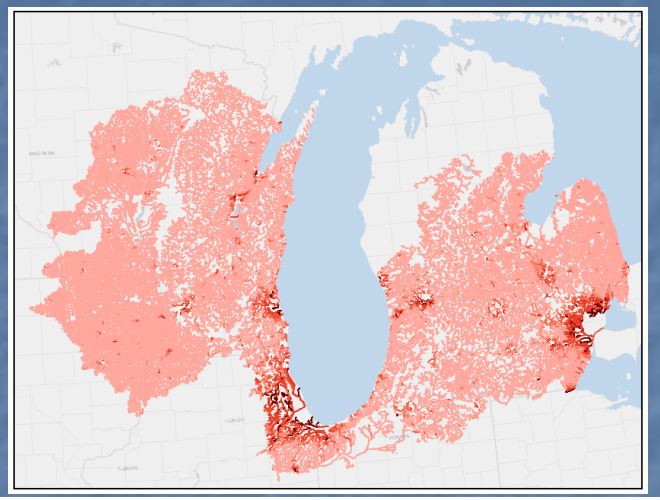


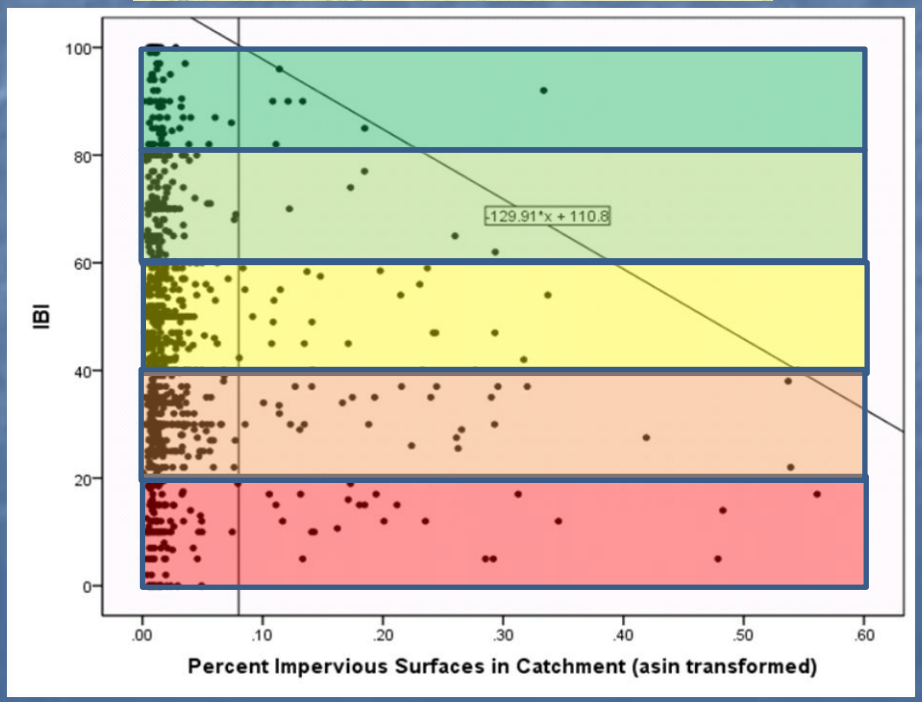


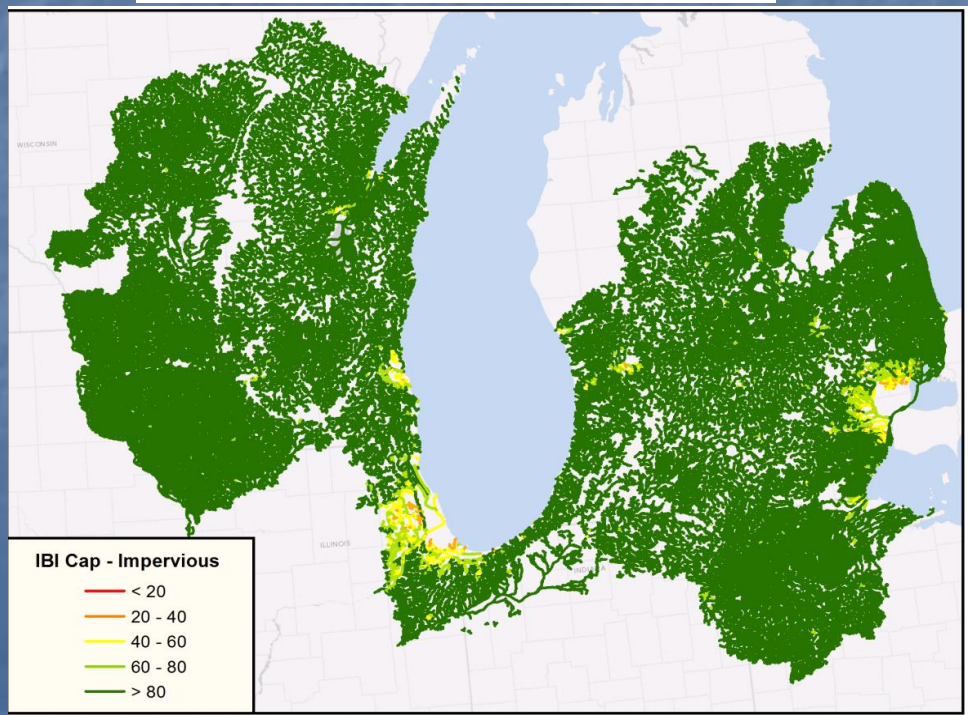


Non-Target Disturbance Limit: IBI and Percent Impervious

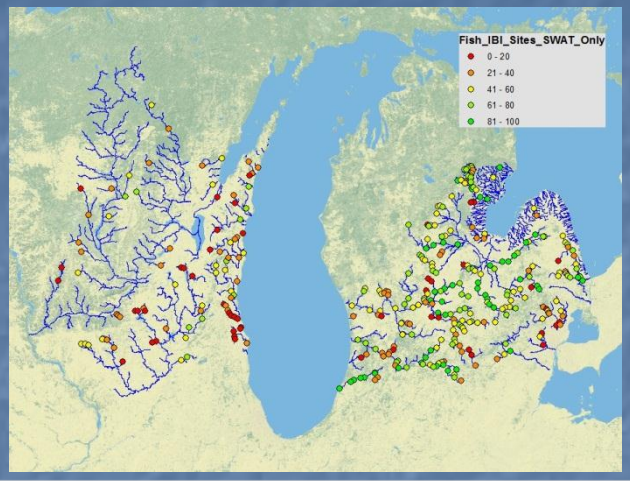


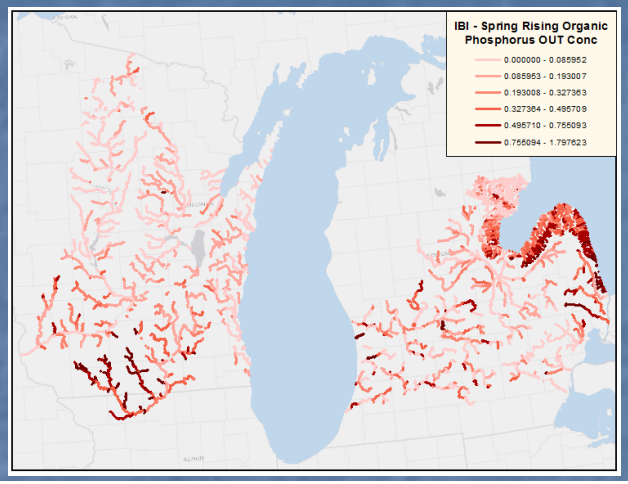


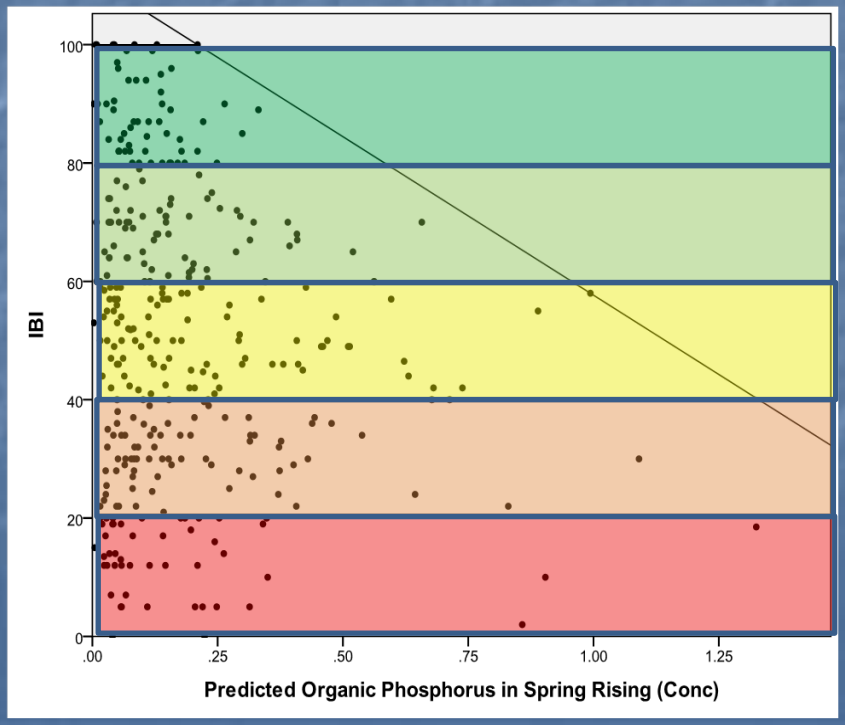


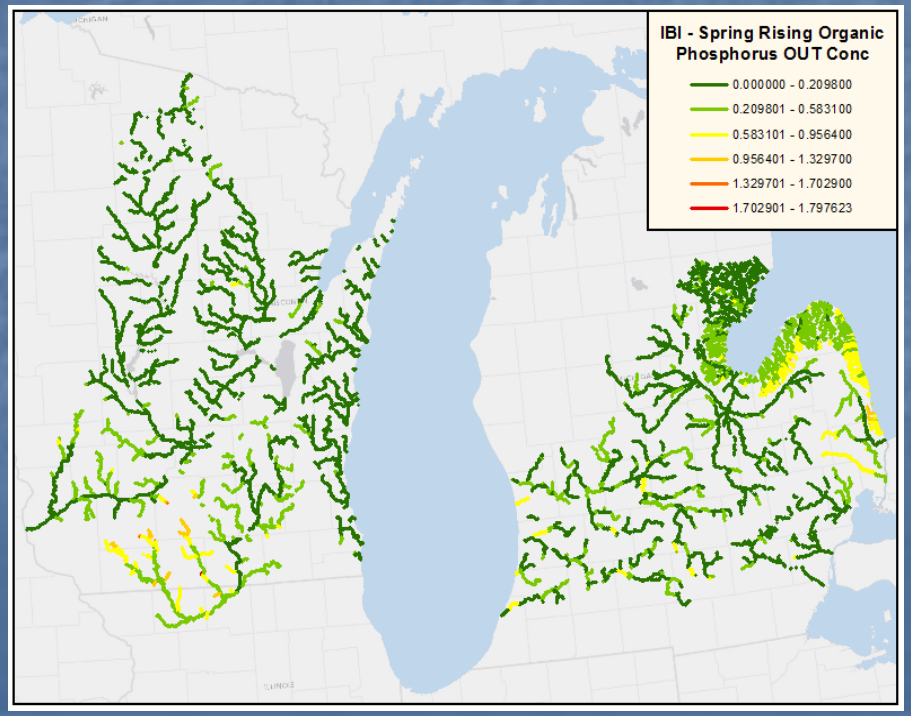


Target Disturbance Limit: IBI and Spring Rising Organic P Concentration

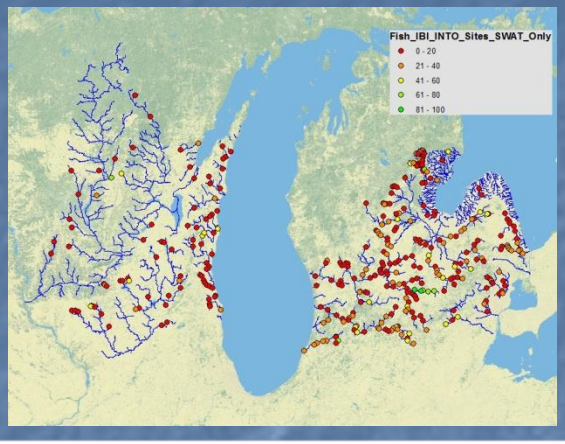


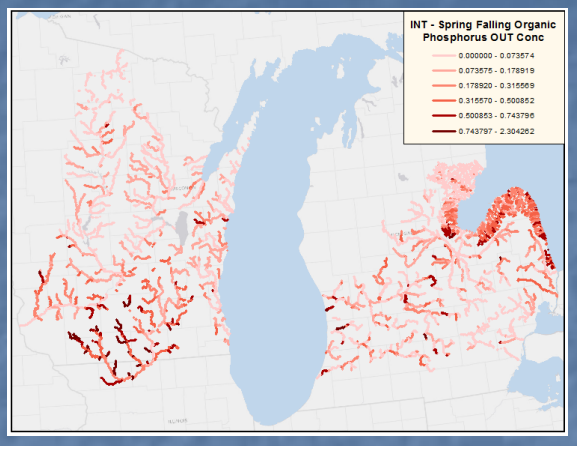


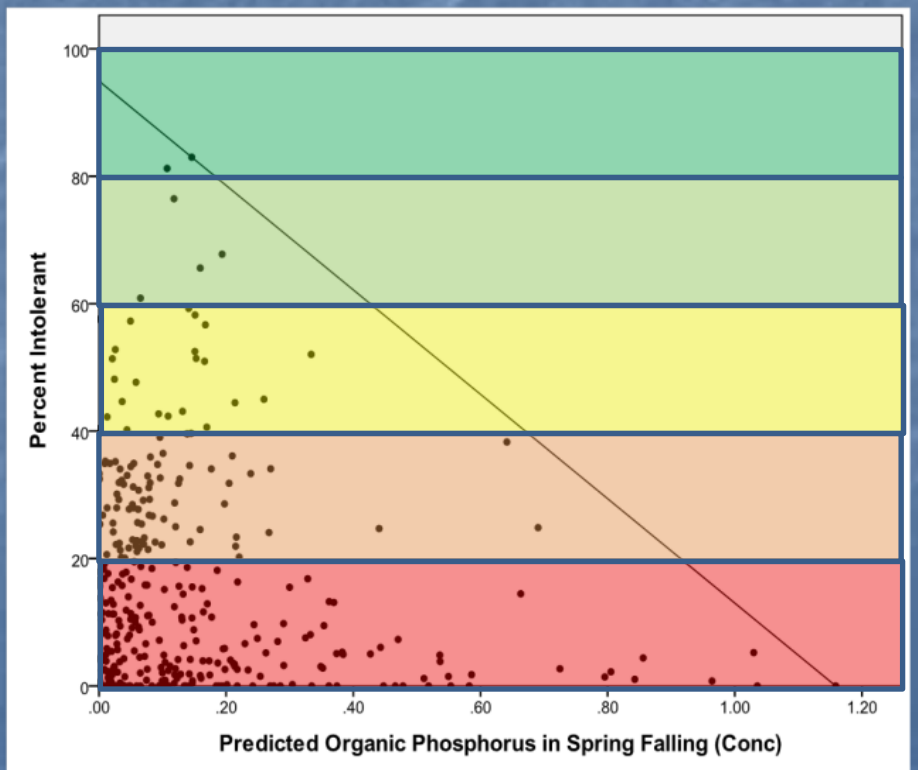


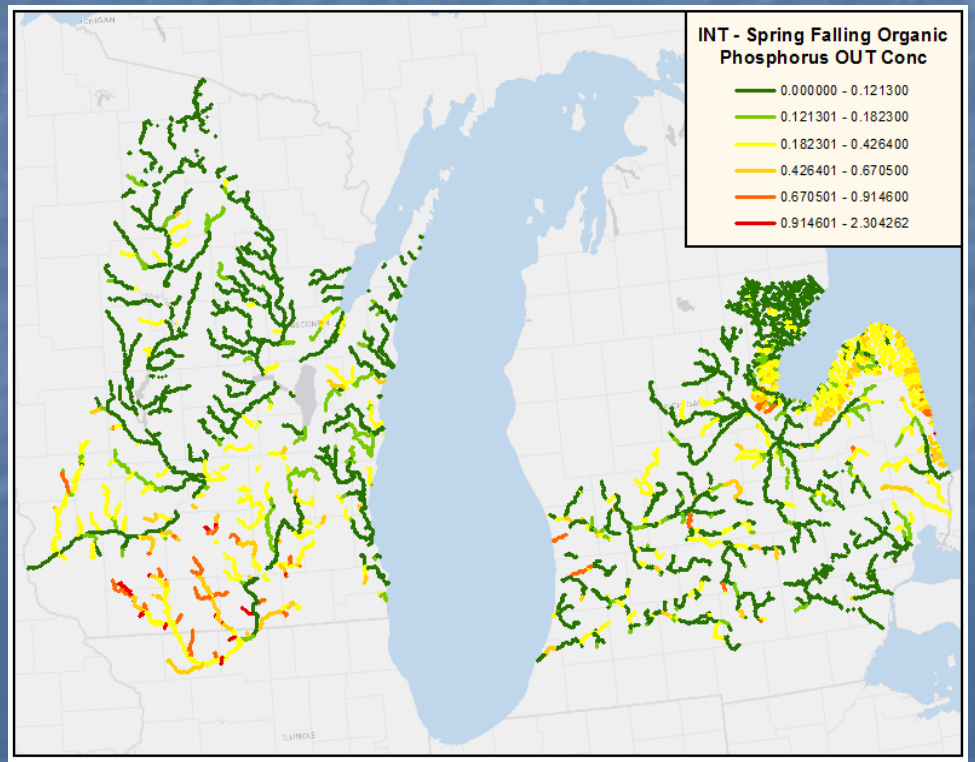


Target Disturbance Limit: %Intolerant and Spring Falling Organic P Concentration



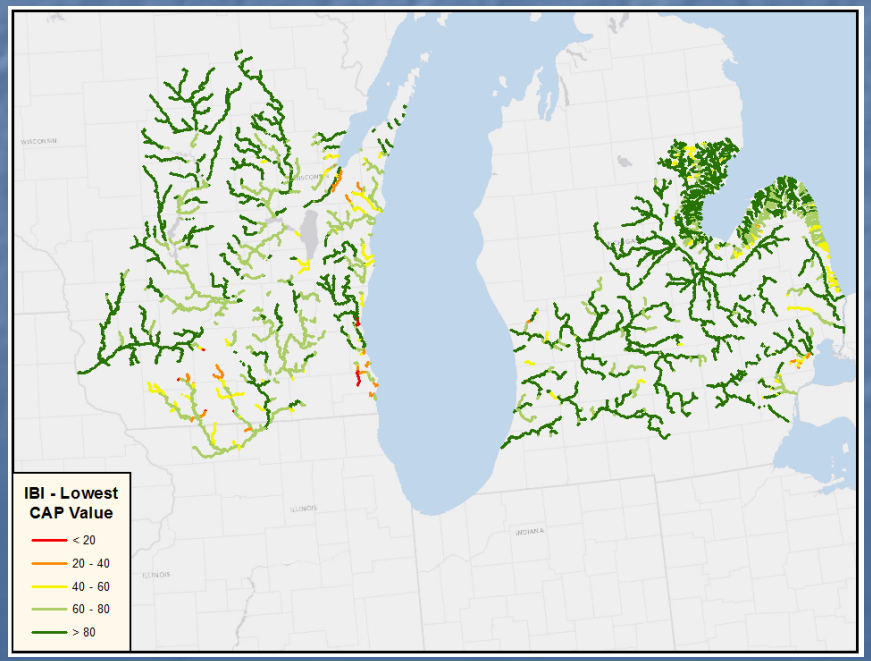


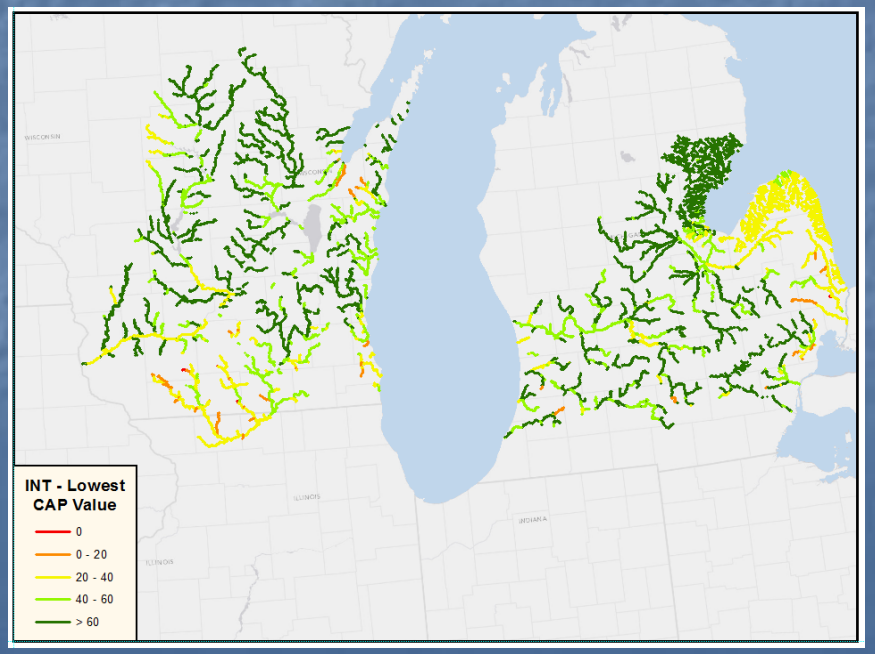




Integrated Mapping of Ecological Limits

	A	B	C	D	E	F	G	H
1	New_UnqID	IBI_pre_001	CAPIBI_SURQmm	CAPIBI_Spr1_ORGP_OUTConc	CAPIBI_LogSum_SEDCONCmg/kg	CAPIBI_Sum_TOTALP_OUTConc	IBICap_AWT_QG3P	IBICap_LogPONDWA
2	040301-040400_1_doorp600_13063073_20551	51.628571	100	100	100	100	100	100
3	040301-040400_1_doorp600_13063835_20552	51.628571	100	100	100	100	100	100
4	040301-040400_10_pendk390_6801354_20659	51.628571	100	100	95.08013793	100	100	100
5	040301-040400_10_pendk390_6801358_20661	51.628571	100	100	95.08013793	100	100	100
6	040301-040400_10_pendk390_6801368_20660	51.628571	100	100	95.08013793	100	100	100
7	040301-040400_10_pendk391_6801354_20662	51.628571	100	100	95.08013793	100	100	100
8	040301-040400_10_pendk391_6801358_20663	51.628571	100	100	95.08013793	100	100	100
9	040301-040400_10_pendk399_6801368_20664	51.628571	100	100	95.08013793	100	100	100
10	040301-040400_10_pendk399_6802086_20665	51.628571	100	100	95.08013793	100	100	100
11	040301-040400_10_pendk438_6802086_20666	51.628571	100	100	95.08013793	100	100	100
12	040301-040400_10_pendk471_6801388_20667	51.628571	100	100	95.08013793	100	100	100
13	040301-040400_10_pendk471_6802086_20668	51.628571	100	100	95.08013793	100	100	100
14	040301-040400_100_shman1201_12175494_15979	51.628571	74.6796077	100	100	100	100	100
15	040301-040400_100_shman1218_12175494_15982	51.628571	74.6796077	100	100	100	100	100
16	040301-040400_100_shman1218_12175510_15981	51.628571	74.6796077	100	100	100	100	100
17	040301-040400_100_shman1218_12175512_15980	51.628571	74.6796077	100	100	100	100	100
18	040301-040400_100_shman1224_12175504_15987	51.628571	74.6796077	100	100	100	100	100
19	040301-040400_100_shman1224_12175506_15983	51.628571	74.6796077	100	100	100	100	100
20	040301-040400_100_shman1224_12175512_15984	51.628571	74.6796077	100	100	100	100	100
21	040301-040400_100_shman1224_12175522_15986	51.628571	74.6796077	100	100	100	100	100
22	040301-040400_100_shman1224_12175536_15985	51.628571	74.6796077	100	100	100	100	100
23	040301-040400_100_shman1242_12175536_15988	51.628571	74.6796077	100	100	100	100	100
24	040301-040400_100_shman1259_12175536_15989	51.628571	74.6796077	100	100	100	100	100
25	040301-040400_100_shman1259_12175870_15990	51.628571	74.6796077	100	100	100	100	100
26	040301-040400_100_shman1271_12175548_15992	51.628571	74.6796077	100	100	100	100	100
27	040301-040400_100_shman1271_12175548_15993	51.628571	74.6796077	100	100	100	100	100
28	040301-040400_100_shman1271_12175870_15991	51.628571	74.6796077	100	100	100	100	100
29	040301-040400_100_shman1278_12175548_15994	51.628571	74.6796077	100	100	100	100	100
30	040301-040400_100_shman1278_12175548_15996	51.628571	74.6796077	100	100	100	100	100
31	040301-040400_100_shman1278_12175552_15995	51.628571	74.6796077	100	100	100	100	100
32	040301-040400_100_shman1278_12175558_15997	51.628571	74.6796077	100	100	100	100	100
33	040301-040400_100_shman1282_12175558_15998	51.628571	74.6796077	100	100	100	100	100
34	040301-040400_100_shman1298_12175568_16001	51.628571	74.6796077	100	100	100	100	100
35	040301-040400_100_shman1298_12175568_16002	51.628571	74.6796077	100	100	100	100	100

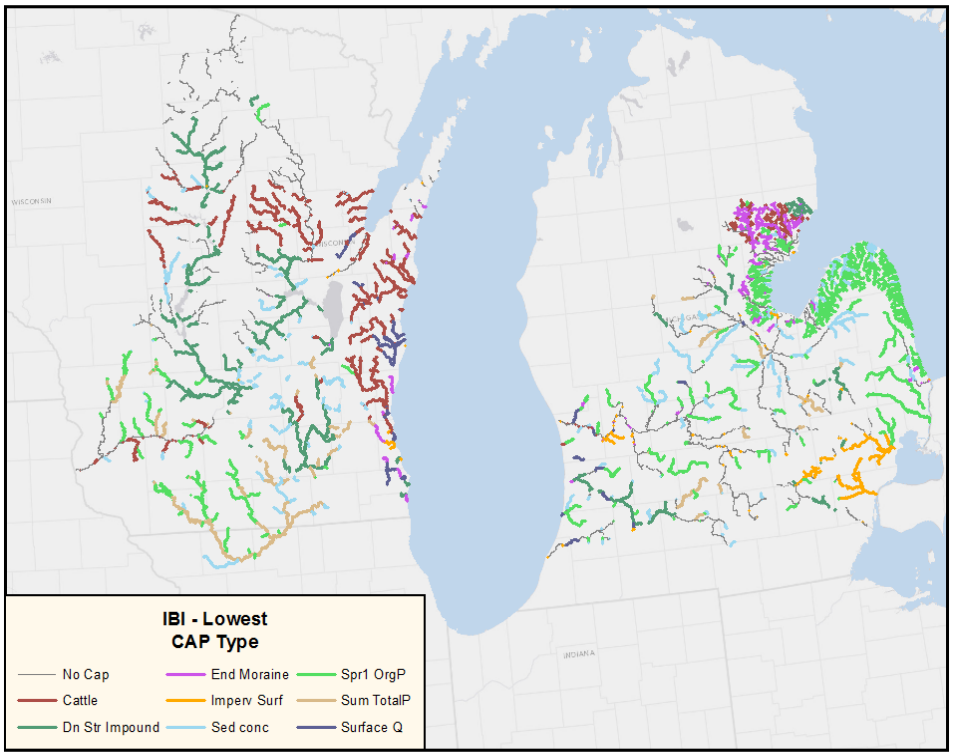


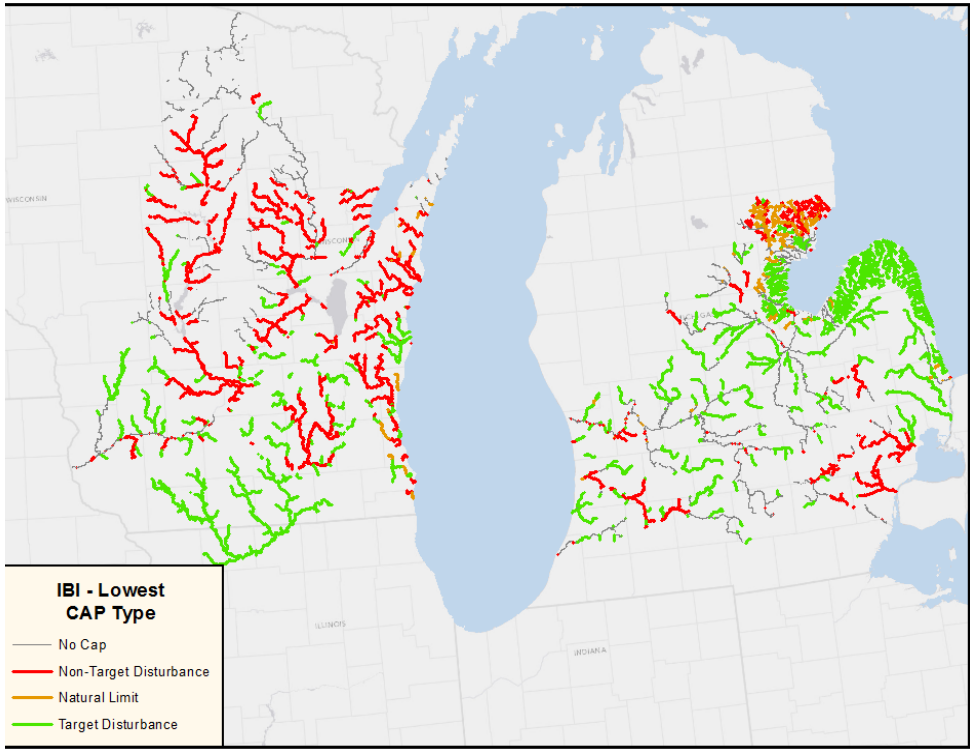


Deciphering Integrated Data

IBI

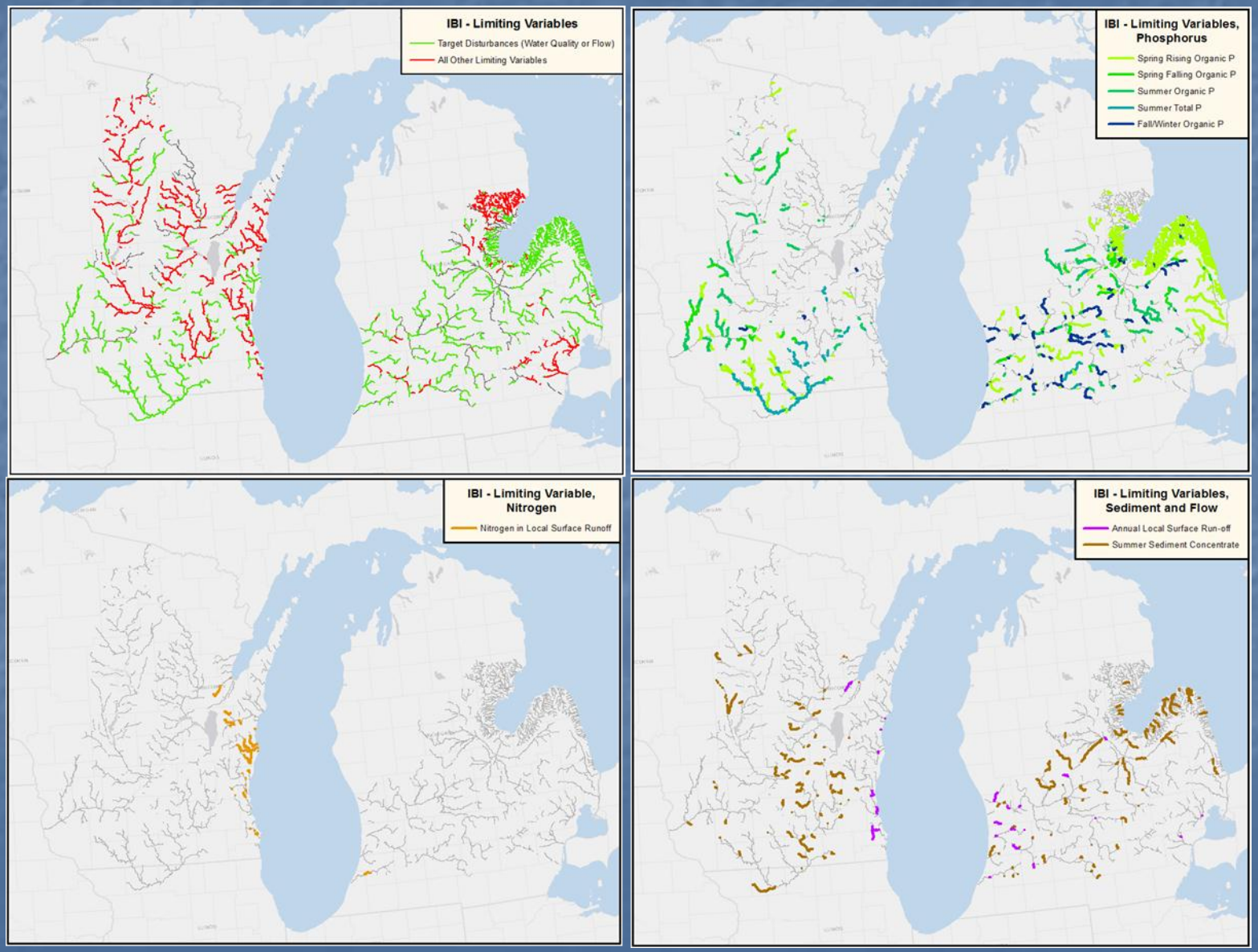
- Which variables are limiting IBI?
- Where are target variables limiting?





Deciphering Integrated Data

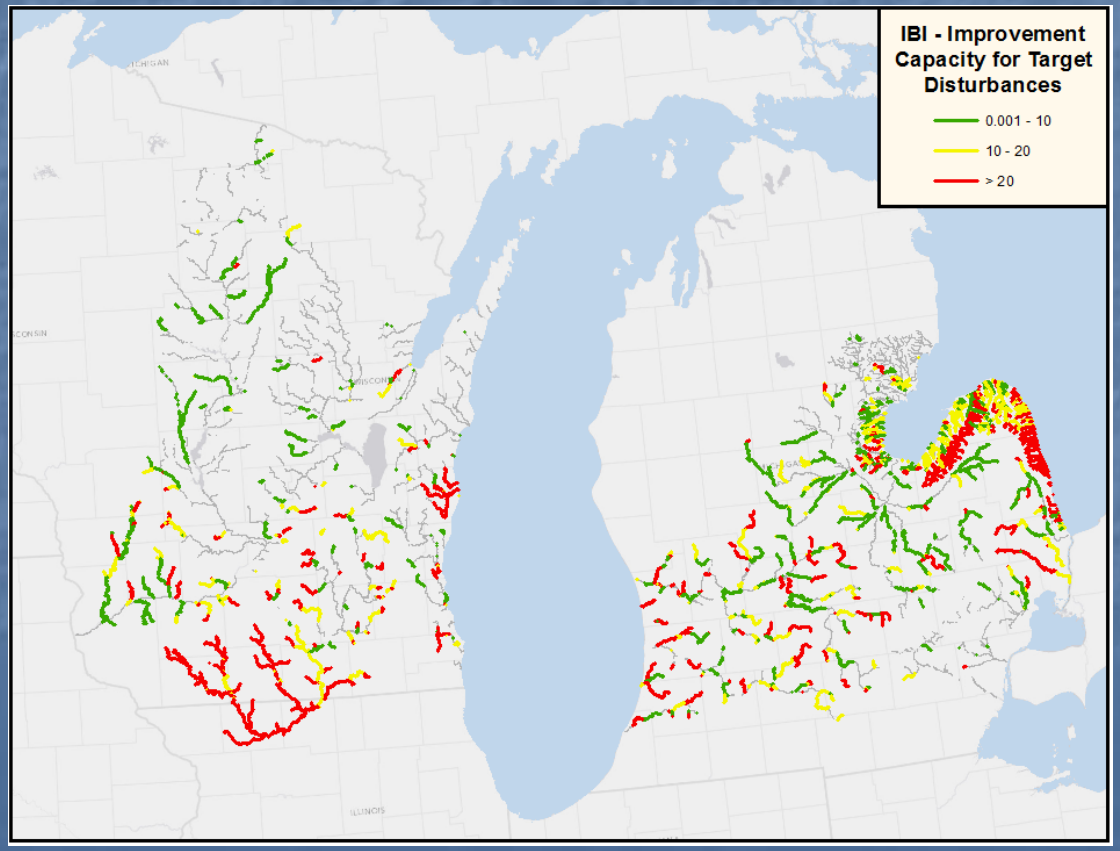
- IBI



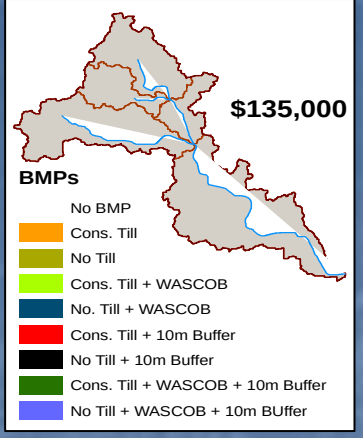
Deciphering Integrated Data

IBI

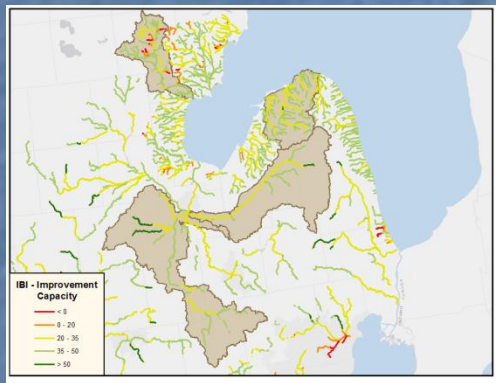
- Where are target variables limiting IBI?
- How much can we improve conditions?

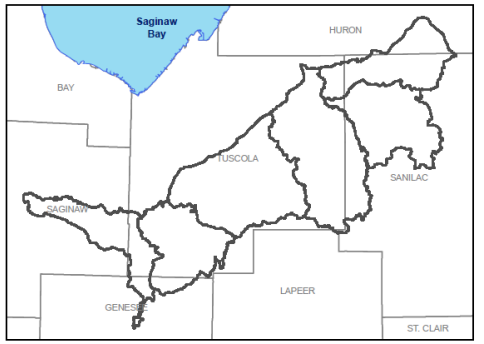


Great Lakes CEAP
Phase 2 Tasks

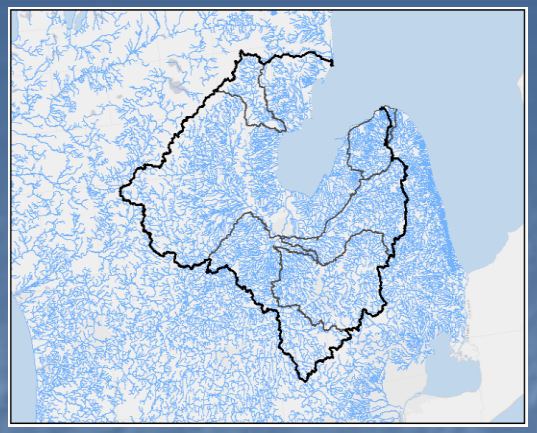


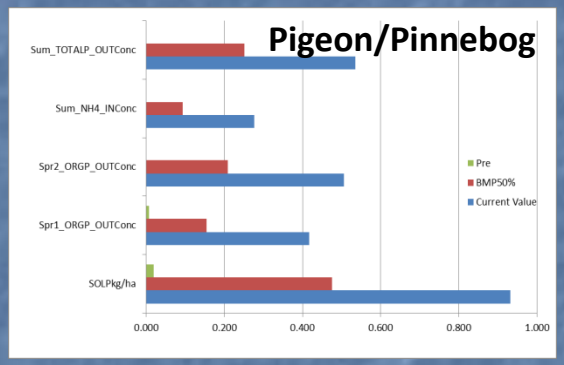
- Within 4 Subwatersheds of Saginaw Bay
  - Use SWAT to model changes in flow and water quality (and fish communities) under different scenarios
    - Current, Medium (25%), High (50%), Historic
  - Assess costs and benefits for each scenario
  - Select priority subwatershed(s)
    - Level 1 priorities
  - Work with key partners to develop:
    - Realistic subbasin goals
    - Subbasin priorities
      - Level 2 priorities

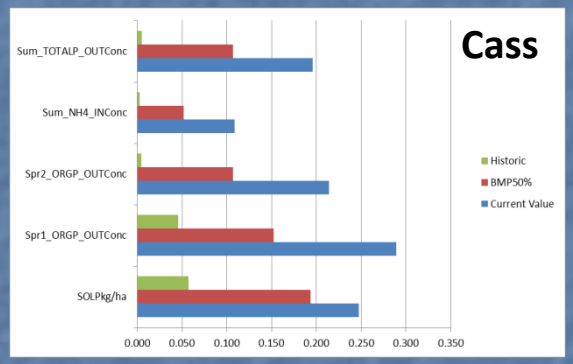


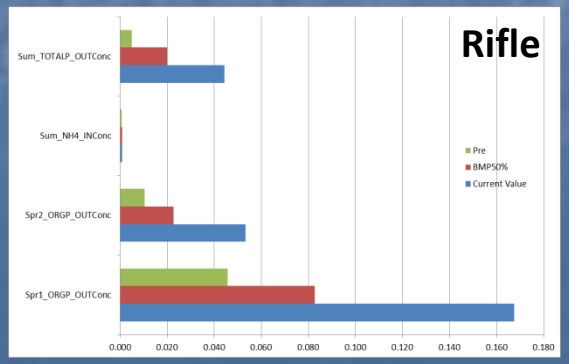


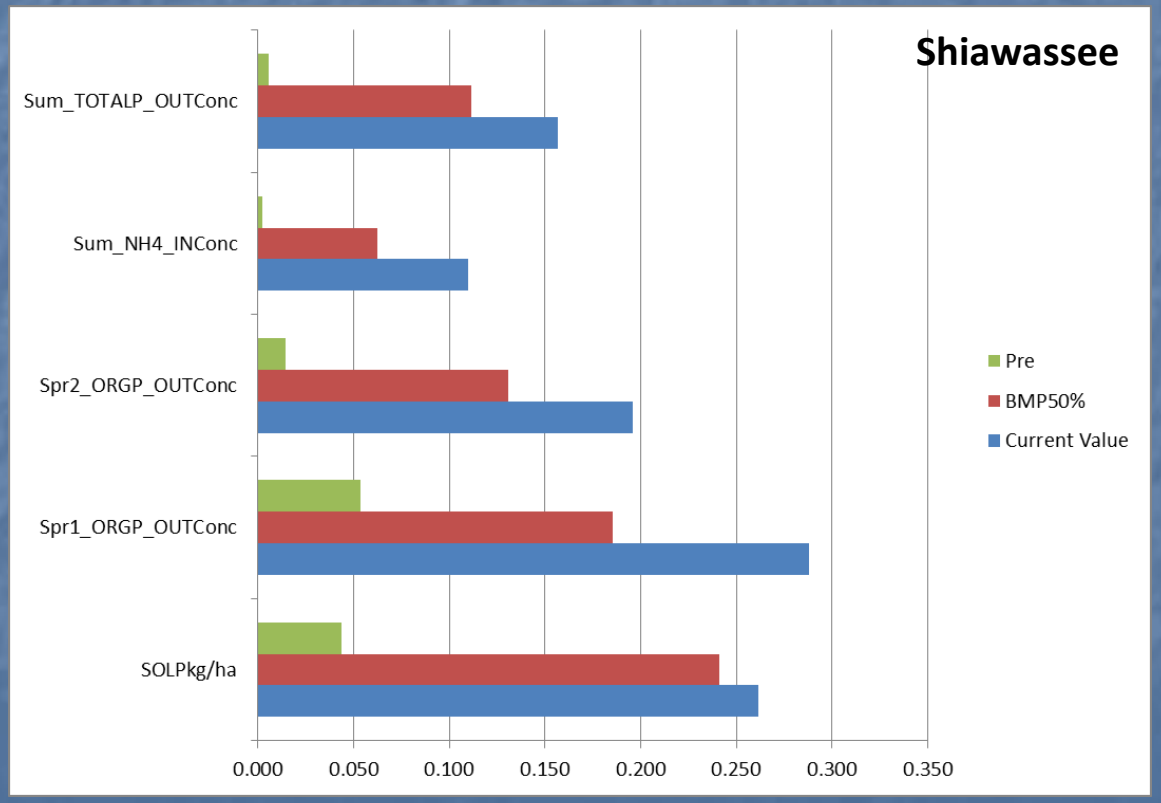
Predicted Water Quality Under Different Scenarios



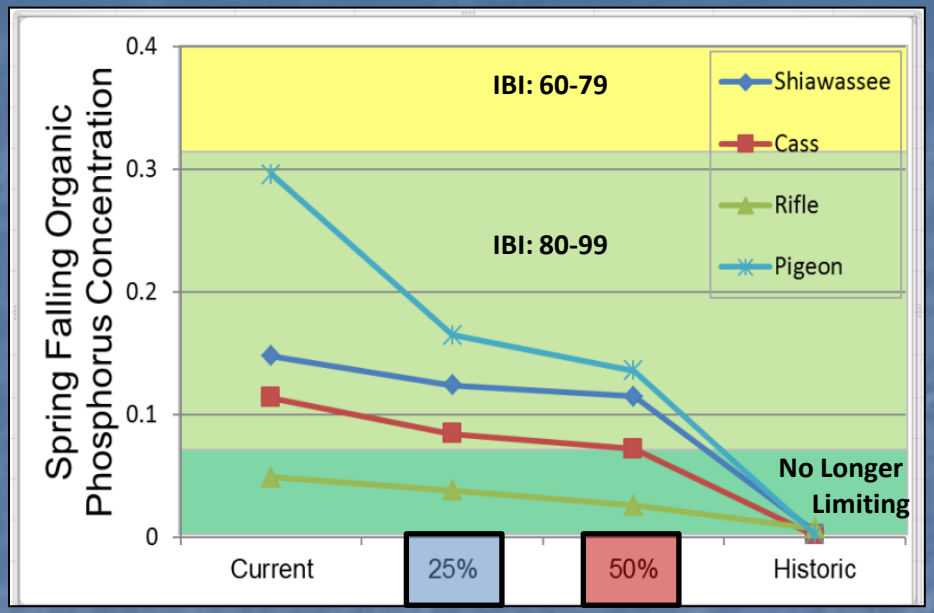


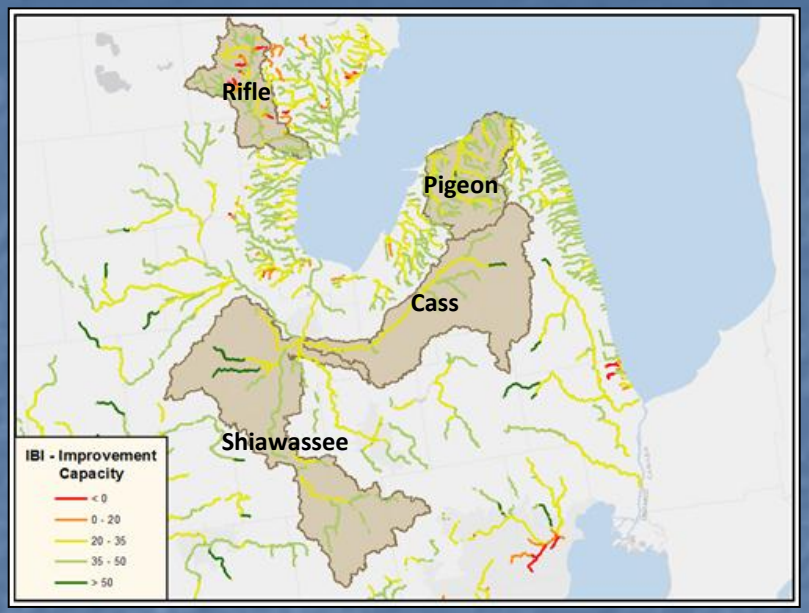




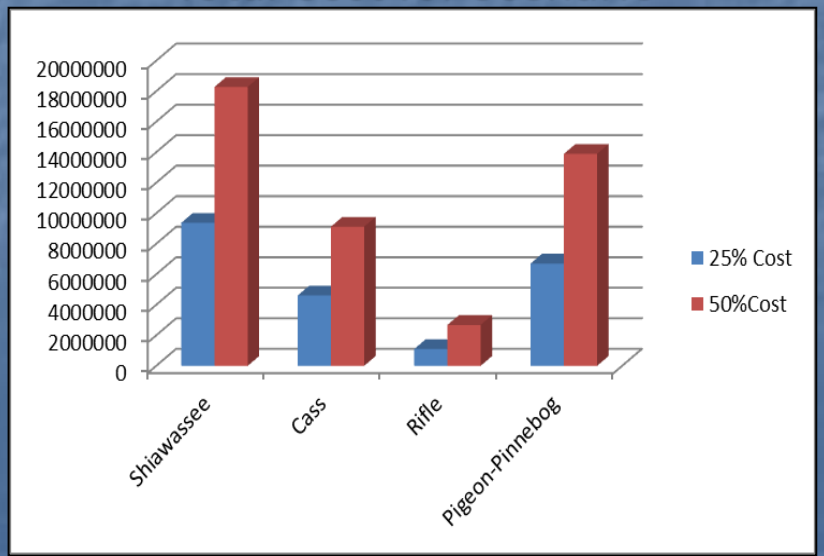


Phase 2: Preliminary Results

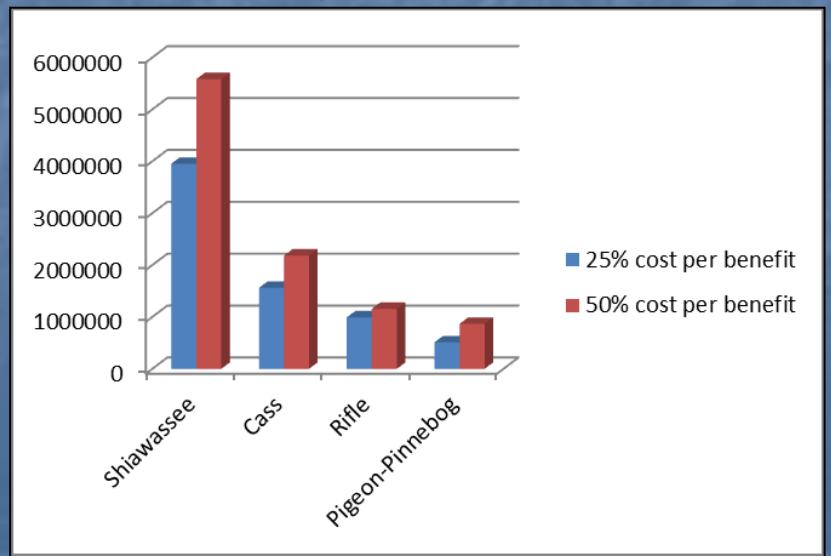




Total Cost for Scenario

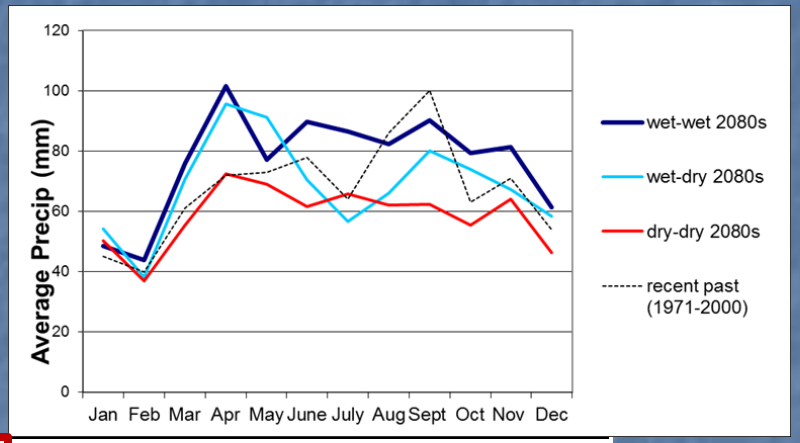


Cost per Unit Benefit



Incorporating Climate Change

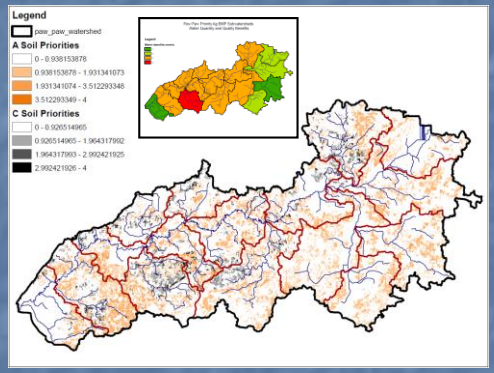
- Three Scenarios focused on Precipitation
- Bad for streams, good for embayments?

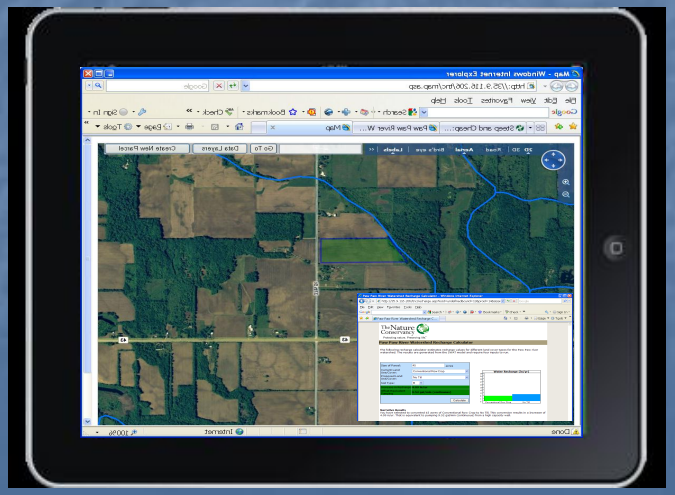


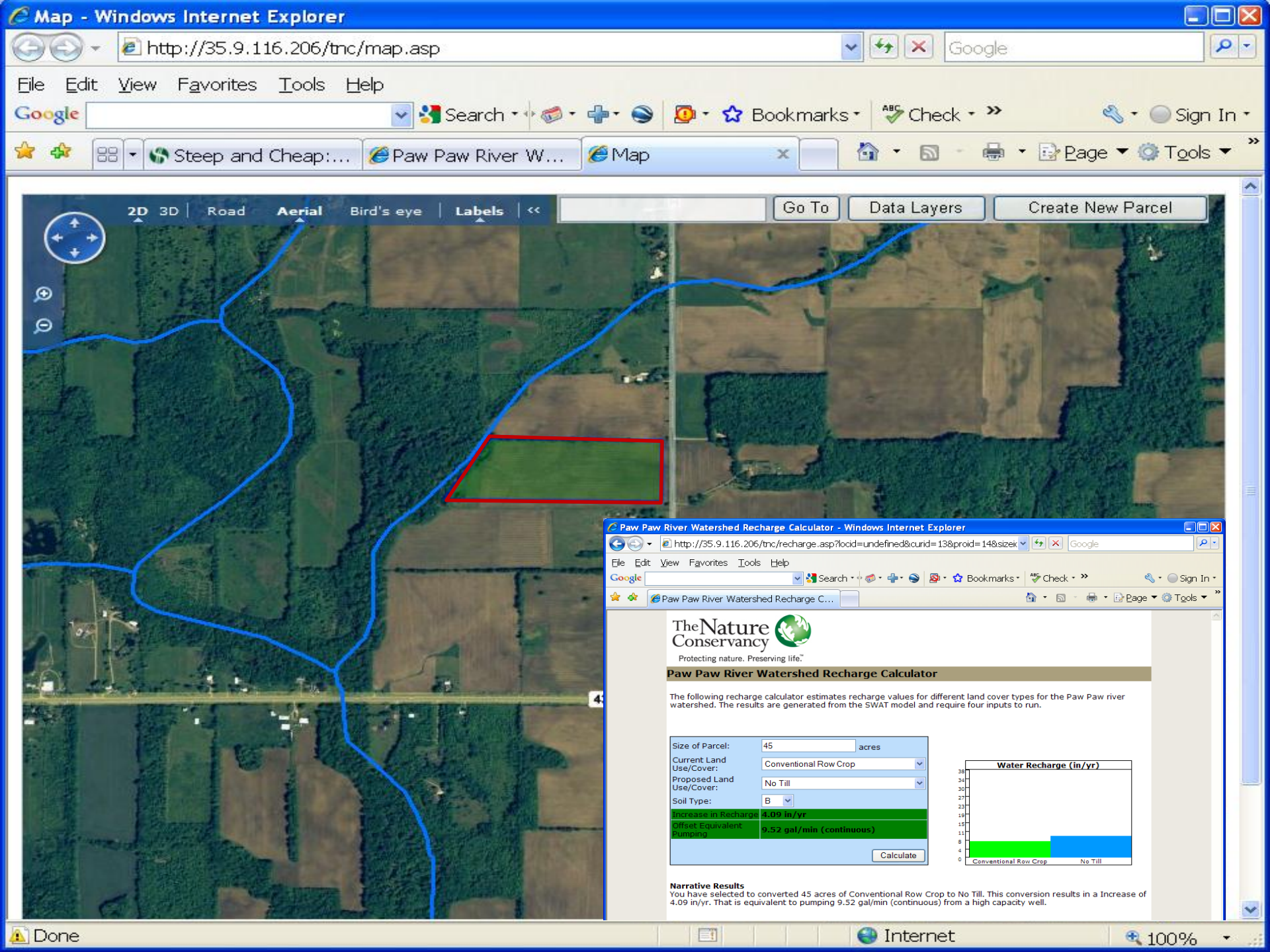
Watershed	Scenario	ORGP (Load)	ORGP (Conc)	Sed (Load)	Sed (Conc)	NH4 (Load)	NH4 (Conc)
Cass	Dry-Dry No BMP	-44.2%	22.3%	-57.8%	-8.9%	-34.4%	43.5%
	Wet-Dry No BMP	-14.9%	20.6%	-31.2%	-4.5%	-4.4%	35.4%
	Wet-Wet No BMP	1.5%	8.7%	-6.8%	-0.9%	13.1%	21.1%
Shiawassee	Dry-Dry No BMP	-44.7%	13.5%	-55.4%	-10.3%	-34.1%	35.3%
	Wet-Dry No BMP	-15.7%	14.2%	-28.6%	-5.8%	-4.9%	28.9%
	Wet-Wet No BMP	1.7%	3.3%	-2.7%	-2.3%	14.9%	16.7%
Rifle	Dry-Dry No BMP	-21.0%	7.2%	-15.9%	0.5%	3.7%	40.7%
	Wet-Dry No BMP	11.2%	11.7%	27.8%	9.6%	28.8%	29.4%
	Wet-Wet No BMP	14.6%	1.6%	26.6%	8.3%	41.0%	25.0%
Pigeon/ Pinnebog	Dry-Dry No BMP	-35.5%	-1.5%	-42.6%	-6.5%	-21.9%	19.2%
	Wet-Dry No BMP	-9.5%	-2.7%	-3.8%	3.9%	6.7%	14.7%
	Wet-Wet No BMP	5.6%	-11.6%	25.5%	11.8%	21.0%	1.3%

TNC Watershed Strategy
Phase 3 Tasks

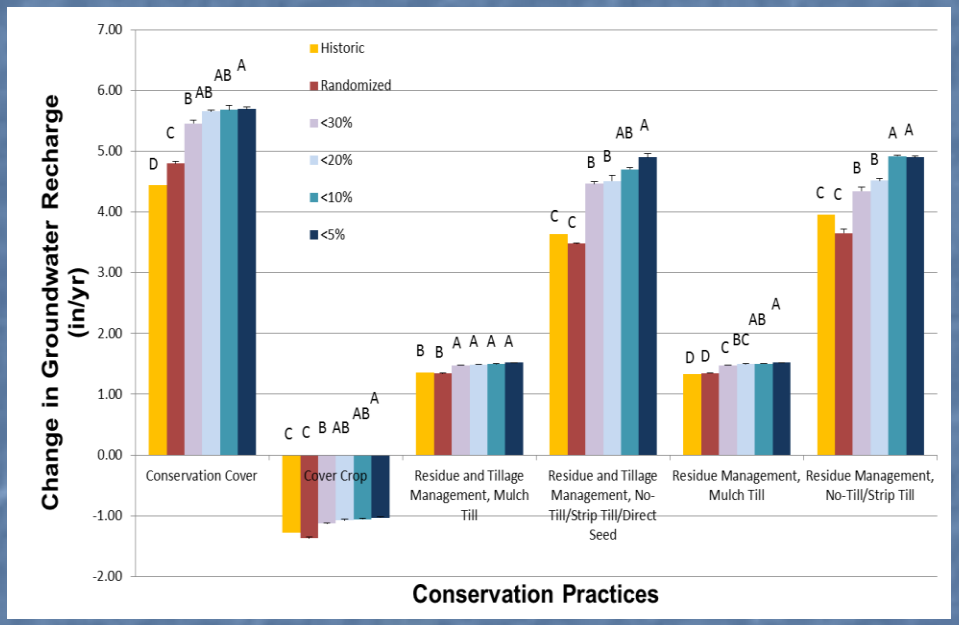
- Develop field scale data and decision tools to support supply chain logistics and Level 3 priorities:
  - Prioritize at 10-30 m pixel to field scale
    - Reduced erosion and sediment inputs (HIT, L-THIA)
    - Reduced nutrient loss (L-THIA)
    - Reduced surface runoff and increased groundwater recharge (SWAT)
  - Facilitate strategic placement of conservation practices (cost/benefit) to more efficiently meet ecological goals
  - Support Transactions
  - Track cumulative placement of conservation practices and progress toward ecological goals
-

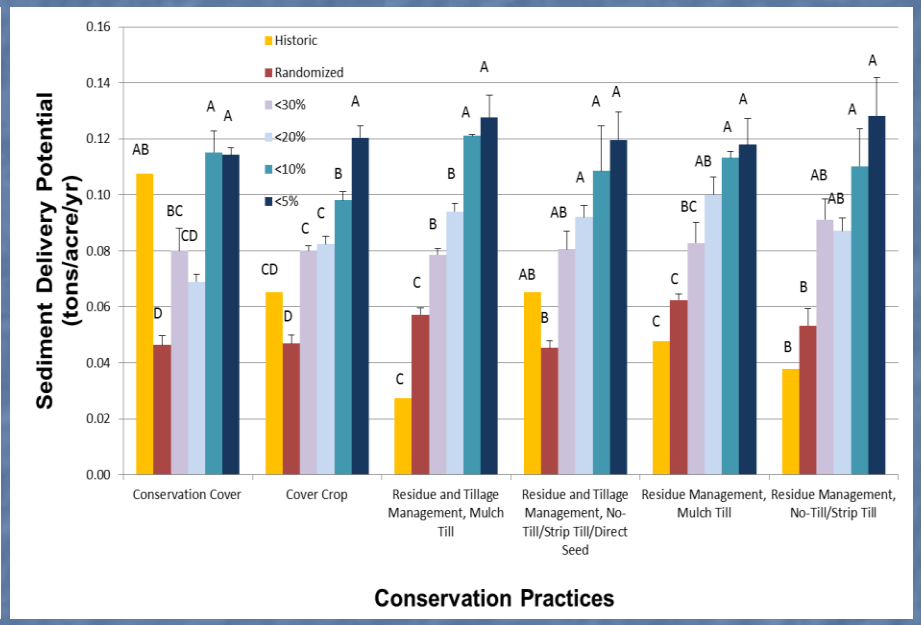





Map - Windows Internet Explorer
http://35.9.116.206/tnc/map.asp
File Edit View Favorites Tools Help
Steep and Cheap:...
Paw Paw River W...
Map
2D 3D Road Aerial Bird's eye Labels
Go To
Data Layers
Create New Parcel
Paw Paw River Watershed Recharge Calculator - Windows Internet Explorer
http://35.9.116.206/tnc/recharge.asp?locid=undefined&curid=13&proid=14&sizek
The Nature Conservancy
Protecting nature. Preserving life.
Paw Paw River Watershed Recharge Calculator
The following recharge calculator estimates recharge values for different land cover types for the Paw Paw river watershed. The results are generated from the SWAT model and require four inputs to run.
Size of Parcel: 45 acres
Current Land Use/Cover: Conventional Row Crop
Proposed Land Use/Cover: No Till
Soil Type: B
Increase in Recharge 4.09 in/yr
Offset Equivalent Pumping 9.52 gal/min (continuous)
Calculate
Water Recharge (in/yr)
Conventional Row Crop
No Till
Narrative Results
You have selected to converted 45 acres of Conventional Row Crop to No Till. This conversion results in a Increase of 4.09 in/yr. That is equivalent to pumping 9.52 gal/min (continuous) from a high capacity well.
Done
Internet
100%

Level 3 Priorities





- ~25-35% increased efficiencies for top 5%
- Legge et al. In Press. Journal of Soil and Water Conservation

Summary

- Fish communities are influenced by WQ and flow
- AG related WQ and flow alterations appear to be limiting fish communities across about 35% of the project area
- What is the limiting factor is highly variable across space
- Can isolate where AG related disturbances associated with WQ and Flow are limiting
- Percent Intolerant fish is a more sensitive metric
- In most instances it appears that we can improve water quality to the point it is no longer limiting riverine fish communities (Does not mean fish community is healthy)
- Possibly a very different story when looking at Lakes

Improving the Approach

- Use multiple taxonomic groups as biological endpoints
- Fill other critical data gaps for predictors (more threat non-target threats)
- Further downscaling SWAT model to minimize loss of biological data
- Incorporate spatially distributed calibration into SWAT model calibration process
  - Use discrete water quality data and maybe SPARROW
- Incorporate better current land use and management data into SWAT model (NASS Survey)
- Incorporate climate change into SWAT model

Acknowledgments

- USDA NRCS CEAP, Mott Foundation, Herrick Foundation, and Americana Foundation for funding
- Coauthors and collaborators
- Jana Stewart (USGS) for GL Aquatic GAP Data
- Dana Infante, Arthur Cooper, Pete Esselman, Gary Whelan and Doug Beard for NFHAP Condition